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TWENTY-NINTH CONVENTION

VOLUME II
Question Box

ATLANTIC CITY, NEW JERSEY
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Question Box

PAUL LÜPKE, *Editor*

"*To keep your knowledge alive you must give it away.*"

—ANONYMOUS

INTRODUCTION

In looking back upon the rather strenuous work of the last few months, necessarily falling upon the editor of the Question Box, *one question (not directly asked) forces itself upon me: "Is it worth while?" and fully realizing that it is, this further question immediately suggests itself: "Is there not some better way of accomplishing the object in view?"*

In the form of the Question Box *a large amount of useful information is presented from year to year in necessarily more or less disjointed form, causing much repetition, increasing voluminousness and some seemingly unavoidable irrelevancy. I therefore venture to suggest the following:*

Let the association appoint a standing committee to be called the "Handbook Committee," whose duty it would be to collect information and data, much in the same way as it is done now for the Question Box, *covering the various departments constituting the central-station business, engineering, operating and management, to properly arrange and edit these data and to embody them in a* Handbook of the National Electric Light Association.

Every year in place of the Question Box *and* Wrinkles *a supplement to this* Handbook *could be printed and, say, every five years a new and revised edition could be arranged for, eliminating obsolete matter and absorbing the new matter of the interim supplements.*

I think that in these days of growing altruism and co-operation enough willing and capable men could be found among the membership of the association who would carry on this work for the benefit of all, taking for their compensation the consciousness of having assisted in the creation of work of high intrinsic value.

This is merely a suggestion offered for the consideration of the association, and I fully realize that the amount of work involved and other valid and concrete reasons may stand in the way of its adoption.

With regard to the present volume of the Question Box *I beg to call the attention of the reader to the following remarks:*

To avoid unnecessary repetition of the answers to all intents *and purposes identical, except in the exact wording, only one (on account of the necessities of the printers, generally the first one received) has been printed and the names of subsequent concurring contributors have been appended to this. While this arrangement does away with many a page it still preserves the weight given by numbers to opinions expressed, and quickly conveys to the reader the information he desires.*

To combine the Wrinkle *department with the* Question Box, *an appropriate question has been inserted for each* Wrinkle *received, and in this manner double indexing, et cætera, has been avoided.*

Much valuable matter has been received too late for use this year, as the Question Box *must be ready for distribution at the convention. It has been suggested that this material might be printed in an appendix to the* Question Box *in the final records of the convention. If this is not done, all unpublished answers will be turned over to my successor for next year's issue.*

I can not but join my predecessors in expressing my thorough appreciation of the tireless efforts by our assistant secretary, Miss Billings, for the success of the Question Box, *and in thanking all contributors for their liberal support I also wish to include Mr. E. C. Stahl, Jr., and Mr. Clarence A. Hutchings, of the Trenton office of the Public Service Corporation, for their efficient and willing assistance.*

PAUL LÜPKE,
Editor.

May 18, 1906.

Question Box

OF THE

Twenty-ninth Convention of the National Electric Light Association

NOTE—Questions marked (*) are included through the courtesy of Mr. Henry L. Doherty, editor of the 1906 QUESTION BOX of the Ohio Gas Light Association.—Editor.

A—BUILDINGS

A 1. Give cost per cubic foot of recent station and substation buildings, stating briefly general characteristics as to material, construction and kind of foundation.

A brick central-station building with no basement, and with walls 18 feet high from floor to bottom of roof trusses, can be built for from $1.50 to $2.00 per square foot. This includes granolithic floor, iron-truss roof framing, and slate roof with Monitor ventilators. H. T. HARTMAN.

(1) A power station designed for crane and
1600 kilowatts in generators.
1000 kilowatts in rotaries.
1600 horse-power in boilers.
Slate and steel roof.
No basement.
Concrete footings up to water table.
Concrete floors.
Steel roof trusses.
No steel columns.
Brick walls.
Total floor area, 8118 square feet.
Cubical contents, 260,460 cubic feet.
Cost of building per cubic foot, $.063.

(2) A power station designed for crane and
1500 kilowatts in generators.
400 kilowatts in rotaries.
800 horse-power in boilers.

Steel and timber roof.
Concrete basement floor.
Concrete footings up to water table.
Concrete floors.
Steel columns and trusses.
Brick walls.
Total floor area, 15,180 square feet.
Cubical contents, 355,740 cubic feet.
Cost of building per cubic foot, $.05.

(3) A power station designed for crane and
1200 kilowatts in generators.
900 kilowatts in rotaries.
1200 horse-power in boilers.

Brick walls.
Concrete footings up to water table.
Concrete and steel roof.
Concrete floors.
Steel columns and trusses.
Total floor area, 16,544 square feet.
Cubical contents, 431,826 cubic feet.
Cost of building per cubic foot, $.061.

NOTE—Estimates of building costs based on cubical contents have very little value, as variations in contents are frequently very great without materially affecting cost, principally due to differences in roof construction. A better rule for making a rough determination of current building costs is the following:

Allow 50 cents per square foot of floor area.
Allow 50 cents per square foot of roof area.
Allow 60 cents per square foot of wall area.

Figuring on one side of party wall but including basement wall.

This will cover a first-class building having
Selected ordinary brick walls.
Concrete footings, roof and floors.
Steel columns and steel trusses and designed to support crane.

H. A. STRAUSS.

***A 2. Does too much water in concrete have bad effects, and if so what are they?**

We think that, aside from the extra labor involved, the only bad effect of too much water in concrete would consist in a tendency toward stratification of materials. F. TOBEY, JR.

So far as the writer has been able to ascertain, the use of large quantities of water in the mixing of concrete does not have injurious effects, but the permitting of the concrete to set with a large amount of water incorporated therein naturally weakens the concrete, as it leaves it more or less porous.

WM. B. JACKSON.

Too much water makes concrete porous. If the excess of water is very great there is a noticeable decrease in strength. The porosity of dry concrete may be prevented by thorough ramming. No amount of ramming will prevent porosity in concrete containing an excess of water. CHARLES W. COMSTOCK.

A large quantity of water has no bad effect on Portland cement concrete. If forms are not tight, excess of water will wash cement away. FRED. W. C. BAILEY.

Too much indicates that the limit has been passed. Much water is sometimes advisable and even necessary and very little water should be used under some conditions. The concrete reaches its ultimate strength after one year if mixed wet, but this ultimate strength is somewhat greater than if gained by a dry mixture. A dry mixture reaches the maximum earlier. A concrete structure should never be loaded to its estimated practical limit (350 to 500 pounds per square inch with good, rich concrete) before it is seven days old.

If you can not afford to wait at least fourteen days, use dry concrete. For the purpose of securing a uniform monolithic mass without voids, wet concrete is preferable in vertical narrow structures. Here, dry concrete should be avoided. On wide, horizontal bed plates this is not necessary.

Dry concrete should be used in cold weather and wet concrete in hot weather. If the water has a chance to freeze before the initial set has taken place, the concrete is absolutely worthless.

These remarks are true only for concrete properly mixed and made of reliable material.

I. O., Westchester Lighting Co.

The question of water in concrete is a matter of considerable difference of opinion among engineers, each man, as a rule, having a different idea as to the amount of water that should be used. Theoretically, only so much water is necessary as will moisten all the particles of cement and sand composing the mortar used in making the concrete. Practically, of course, it is difficult to adjust the use of water so that concrete will not run too dry or too wet at times.

Concrete with too much water, I believe, is a safer mixture to use than concrete with too little, as it is not certain the latter will set. I have seen concrete put in large foundations so wet as to shake like a bowl of jelly, yet when set the concrete was as hard as stone, and of the best quality.

As to the bad effect of a large amount of water in concrete, I do not know of any except the difficulty of tamping; but for this reason, if no other, I favor concrete that is neither too wet nor too dry, but with just enough moisture to permit of tamping well, when a slight film of moisture should appear on top. This I think applies to concrete used in thin layers or small spaces, as in conduit construction, more particularly than in heavy foundations.

A great deal of stress is often laid on the amount of water in concrete and not enough on the tamping. As a matter of fact, it is the tamping that gives the strength, provided the cement is good and the proportions right.

Concrete well tamped is about one-third to one-half stronger than concrete with little or no tamping.

Geo. B. Springer.

***A 3. Is it advisable to use water-gas generator clinkers and ashes for concrete instead of stone in any kind of foundation work?**

In using clinkers to replace stone in concrete one should be very careful to select only that which is very solid. Very much of it is easily broken, and would weaken the work.

F. Tobey, Jr.

Clinkers and cinders make a light, porous concrete, suitable for self-supporting floors and in other situations where there is no liability to the absorption of moisture and where dead weight is undesirable. Cinder concrete is not as strong as similarly proportioned stone concrete. In foundation work, where dead weight is to be expected, cinder concrete is not advisable.

Charles W. Comstock.

It depends upon the amount of sulphur there is in the clinkers. If they are sulphur-free or almost so, they make good light concrete. If weight is the first consideration, broken-stone concrete is best where the structure should be heavy (for instance, sub-foundations for reciprocating engines) and cinder concrete where the structure should be light (for instance, reinforced concrete floors). Compressive strength should also be taken into consideration.

The following table should be enlightening:

WEIGHT

Cinder concrete	105 pounds per cubic foot
Stone concrete	140 pounds per cubic foot
Gravel concrete	150 pounds per cubic foot

STRENGTH (ULTIMATE)

Cinder concrete	1600 pounds per square inch
Stone concrete	2750 pounds per square inch

If the clinkers contain sulphur in dangerous quantities this may be counteracted by using a cement that contains a corresponding amount of excessive alkalies. The engineer is afraid of sulphur in concrete; he is afraid, not because he knows so much of its dangerous character, but because he knows so little. In connection with steel, however, it is always bad.

I. O., Westchester Lighting Co.

A 4. Is it desirable to employ the all-concrete construction for power-house buildings?

The writer finds that a power plant having a single floor with 18-foot walls and one room 80 feet by 57 feet and another room 46 feet by 40 feet constructed of hollow concrete blocks, making a wall 10 inches through has proved thoroughly satisfactory. The power plant appears to be easily heated and is not unduly damp. WM. B. JACKSON.

Reinforced concrete is excellent construction for power plants, car houses and substations, especially for heavier work, but it can not compete with small, low buildings using nine-inch brick walls with pilasters. Concrete buildings not faced with brick present a very homely appearance. FRED. W. C. BAILEY.

If the material necessary for concrete is available and cheap, an all-concrete building should be acceptable. It is largely a question of expense compared with other kinds of buildings.
THE COLORADO SPRINGS ELEC. CO.

There is no reason why concrete construction for power-house buildings should not prove satisfactory, provided the concrete is properly reinforced with steel. H. A. STRAUSS.

Desirable is not the word for it. It will become a necessity when wages of bricklayers have reached the commercial limit. The important question now is to work out some standard designs useful for different purposes, not too expensive to carry out, and fit to stand the criticism of an artistic mind.

I believe, however, that it should not be "all concrete," but concrete in its proper place, and steel so long as it can be purchased for a reasonable price.
I. O., WESTCHESTER LIGHTING CO.

A 5. Assuming that for short spans all-concrete and for long spans steel-truss roof construction is the cheaper, at what width of span is the turning point?

I question the correctness of the assumption that for short spans all-concrete will be cheaper than steel-truss roof construction. Competitive designing, together with the inability of most purchasers to judge of the quality of steel construction, has produced an era of flimsy roof construction in which nothing else can compete in the matter of first cost with steel trusses.

Granting the assumption, however, the matter is so much one of detailed design and type of construction that a general answer is of doubtful value. Some studies and designs that I have made lead me to believe that all-concrete will be cheaper than *equally good* steel construction up to spans of 60 feet. Further study may extend this limit. CHARLES W. COMSTOCK.

From the standpoint of pure cost, span of about 25 feet is the turning point. FRED. W. C. BAILEY.

A 6. Where it is desirable to make the crane available for handling machinery in basement, such as condensers, pumps, valves, piping, etc., can you suggest any better removable flooring than iron or steel plates?

Grooved iron sections with lead surface insertions are excellent; also small panels of reinforced concrete with steel edges. The former is preferable. FRED. W. C. BAILEY.

Where it is necessary to use an overhead traveling crane to handle apparatus in the basement of the station, it is much better to leave permanent openings in the floor than to provide removable sections of floor. The permanent openings provide light and ventilation to the basement and enable the watch engineer to observe conveniently the operating of the machinery in the basement without having to go down stairs. I. E. MOULTROP.

This depends very much upon how these machines and appliances are distributed. The crane should be so designed and so arranged as to cover all parts of the machinery. Very difficult to apply any general rule. Grill plates are generally good for this purpose and are easy to walk upon. Common iron grating is not. W. W. TITZELL.

Iron or steel-plate floor construction will, in general, be found to be the most satisfactory.

However, where it is necessary to reduce cost of this work, flag-stones laid in channel-irons work out very well. This is particularly the case for covering trenches, pits and tunnel work in power station. H. A. STRAUSS.

A 7. Is it safe to use a cement floor in a room where alternating-current machinery, operating at 2200 volts or higher, requires handling of the parts by operator?

Where a cement floor is installed in a station operating at any voltage above 500, all apparatus requiring handling should be surrounded by a portable flooring raised at least four inches above the cement floor and made in sections so as to be readily removed for sweeping and cleaning. I believe this to be more satisfactory than rubber mats, whose insulating qualities are at times doubtful. F. M. VANDER VOORT.

It is eminently unsafe to handle electrical apparatus of any dangerous voltage when standing upon plain concrete floor, for although when the concrete is dry it may be an excellent insulator, yet when wet this is not the case. The writer has seen people seriously burned when in contact with 500 volts and standing upon a damp concrete floor. WM. B. JACKSON.

Before handling apparatus having a high potential on it, the operator should be perfectly sure that he is sufficiently insulated. He can not be sure on this point in trusting to the floor alone, no matter of what material. A floor that is supposedly insulating is more dangerous than a floor known to be conducting. Character of floor should not enter into point raised by question.

P. M. LINCOLN.

Proper insulation, such as a hardwood platform, rubber or cork mattings, *et cætera*, should be provided for the protection of those handling 2300-volt apparatus installed on cement floors.

For very high voltages the mat should be supported on light frames of wood. W. W. FULLER.

(Practically concurrent opinions expressed by L. D. NORDSTRUM, F. C. S., MALDEN ELECTRIC CO., P. H. KORST, L. L. ELDEN, ERNEST F. SMITH, WARREN PARTRIDGE.)

Not safe to handle bare live parts from bare floor, especially if reinforced concrete. FRED. W. C. BAILEY.

It is, in my opinion, as we have operated a 2200-volt direct-connected unit for three years and have had no trouble.

A. O. FRETZ.

There should be no appreciable danger from a cement floor if apparatus is properly installed.

THE COLORADO SPRINGS ELEC. CO.

Yes; but attendant should be careful to avoid contact with live parts of apparatus. This rule also applies to wooden floors. Insulation of apparatus should be sufficient to permit grounding of frame, regardless of kind of floor.

I. O., WESTCHESTER LIGHTING CO.

A 8. What kind of materials are best for (a) foundations for dynamos and engines? (b) Floors for engine and dynamo-rooms?

(a) Concrete in its regular form or reinforced with iron or wire is no doubt considered the best foundation for dynamos and engines.

(b) This is subject to very few objections for engine and dynamo-room; the only objections, if any, are due to the fact that it is difficult to cut out connections of steam pipes, *et cætera,* that are imbedded in the same. It is, however, now common practice to have a considerable space between the engine-room floor and the ground, for the purpose of examining wires and steam piping, in which case I should consider a concrete floor superior to anything else. A. W. Zahm.

(a) For foundations of dynamos, engines and turbines, the materials best adapted for the purpose are brick and concrete. The considerations governing the choice of either are principally the cost of materials and labor, and sometimes the appearance of the finished work. If the foundation is to be large, and is at all unsymmetrical or cut up, concrete should be adopted without question. If solid piers can be used, brickwork is easily constructed and usually cheaper. If the foundation is exposed above the engine-room floor-level, brick is usually adopted, and in any case it would be used for the outside course of exposed surfaces, and would preferably be enameled brick.

The appearance of concrete work can be very greatly improved, and the cost of forms considerably lessened by using rough instead of planed lumber and tacking thin, black sheet-iron (about 24 gauge) over the entire inside surface of the form. A coat of liquid grout applied with a whitewash brush over the exposed surfaces of the foundation, after the forms are removed, gives the job a very smooth and neat appearance. In large horizontal turbines, where the only foundations are comparatively small piers, and where the height of the pier is great, we have used concrete with 0.75-inch twisted-steel reinforcing rods placed vertically 6 inches from surface of pier, the rods extending into the concrete sub-foundation 18 inches. On the generator piers where the shape used was a hollow rectangle, the rods were placed on 3-inch centres in rows 6 inches from both inside and outside surfaces.

(b) The materials best adapted for floors of engine and dynamo-rooms are concrete arches with granolithic surface, concrete arches with tile surface, or cast-iron floor plates on steel structure. Where concrete arches are used, the granolithic surface should be at least 3 inches thick over the beams. Square tile of sufficient thickness to insure stability under heavy weights, and of a dark color, makes a very neat flooring and is very easily kept clean. The use of cast-iron floor plates is not recommended, excepting where it is necessary to have the crane available for handling apparatus in the basement. Floor plates are hard to keep clean, are usually slippery with oil, and it is extremely difficult to make a neat job with them. Where necessary, for the reason mentioned above, they should be heavily checkered, ribbed, and provided with slipping spots and lifting slots. The ribs should extend from flange to flange of supporting beams with slipping spots at end of each rib.

Every plate must be immovable, the edges of adjacent plates must coincide, and the division line between adjacent pairs must be unbroken, to insure a good job.

THE BROOKLYN EDISON, G. L. KNIGHT.

(a) We deem it so after having made a trial.

(b) It has been our experience that furring strips, lathing and plastering are necessary. A. R. MACKINNON.

(a) Concrete. There is less deterioration, more homogeneity, less cost at present price of materials, and the labor item alone in building foundations is an important factor, as it requires no especially skilled labor to put in.

(b) Tile. It is easier to clean, of better appearance, no danger from fire, and will outlast any other form of floor; the tiles, however, must be of proper glaze and finish.

F. D. SAMPSON.

(a) Concrete, slushed in forms.

(b) I prefer hard-wood floors where machinery operation at 2200 volts or higher requires handling of live parts.

L. W. GREENE.

(a) Concrete made up in the ratio of
1 part Portland cement,
3 parts sand,
5 parts broken stone.
Mix and pour very wet.

(b) In general, steel and concrete.

H. A. STRAUSS.

(a) Concrete, because it is cheaper and better, can be made with cheap labor and is a solid rock when done.

(b) Concrete, for above reasons and because it is practically non-absorbent.
WALTER FLINT.
A. PETERS.

A 9. (a) Is concrete-block construction suitable for central-station buildings? (b) Is it found practical to plaster on concrete blocks with double air space, in cold climate, without additional lathing and plastering?

I have found concrete blocks suitable for central-station buildings and have plastered, with a patent plaster, on concrete blocks having air space, with good results. L. W. GREENE.

(a) Yes. Properly used it is the best building material yet devised.

(b) Yes. Even with single air space there is no trouble. It should of course be a *dead air space*. WALTER FLINT.

Our central-station building is constructed of Palmer hollow-concrete blocks. It has stood two Wisconsin winters and no moisture or frost penetrates the walls. It is satisfactory in every respect and makes a very handsome building.
P. H. KORST.

B—WATER-WHEELS, WATER-POWER, ETC.

B 1. What percentage of friction is there in a rope-drive from vertical water-wheel to horizontal shaft?

This depends altogether upon the power transmitted and upon the design of drive and number of ropes used. It may run as low as three per cent and it is likely to run up to five or six per cent. W. W. TITZELL.

B 2. In a combined water-power and steam plant, is it practical to use the overflow from condensers for the purpose of preventing or reducing troubles due to ice?

Anchor ice has blocked the operation of water-power plants since the "year one" of water-power use, and will continue to do so, probably, to the end of time.

Hollow rack bars, to be heated by circulating steam through them, have been invented, and perhaps tried, but no successful use of them is known to the writer.

A computation made for a 5000-hp wheel as to the amount of electric power that would be required to heat the rack bars sufficiently to prevent the formation of anchor ice on them, showed that it would require the whole output of the wheel to do this, leaving nothing over to be transmitted. Consequently, the over-flow from condensers might somewhat palliate, but is not likely to cure, the evil.

Shutting down the water-power plant and running by gas or steam during the very short time that anchor ice lasts, ordinarily only thirty or forty hours in the year, is a method of avoiding trouble; in certain cases the most economical or expedient. CLEMENS HERSCHEL.

B 3. How does frazil or anchor ice affect your plant? (a) Does it block your racks? (b) Does it reduce the output of your water-wheels? (c) Does it stick the gates and thus make regulation impossible?

I have found it necessary to shovel out or thaw out with steam rack, penstock and wheel case of standard wheel when a large quantity of water was used.

A large penstock in proportion to the amount of water used will allow ice to pass through without harm, provided it is kept stirred up at the rack. Anchor ice is the worst trouble we have to contend with in this climate. B. W. HUTCHINS.

In business eight years and have had no anchor ice. We have an eighty-acre pond, which is quite deep, so that frazil melts before reaching head gates. THOMAS GRAY.

(a) Yes.
(b) Yes.
(c) Yes.

Having three hydraulic plants connected, in case of anchor ice we endeavor to shut one plant down long enough for the race to freeze over, after which the trouble ceases at this point.

P. H. Korst.

Up to date anchor ice has not caused any interruption to our service. It has blocked our racks to such an extent that the only satisfactory remedy was to take the racks up entirely, and the latter part of this winter we have been operating without any protection except that afforded by the booms and the continuous patrol, night and day, of the forebay. We have had the ice stick to the gates to such an extent that it so lessened the flow of water to the wheel buckets that the machines lost speed, and therefore showed voltage below normal. This did not affect all the units, however, but only those nearest the forebay; in other words, the ice seemed to escape in the first wheels. Thus it can be seen that regulation was impossible, not because the ice blocked the gates, but because the ice lessened the gate openings.

Farley Osgood.

We have always been troubled more or less during the winter months with anchor ice forming or filling the turbines and eventually freezing them up solid, causing a shut-down during the night and greater part of the following forenoon, thereby causing a shut-down of water-power of from eight to fifteen hours per day at frequent intervals during thawing and freezing weather. During the winter just past we installed a steam pipe to the penstocks, with a delivery pipe leading to the top casing of the turbine, which are Leffel-Sampson forty-five. With this arrangement we are able to keep wheels running at all times with small expense for steam, using a fifteen-inch pipe, sixty feet of run from boiler with 100 pounds steam about fifteen minutes at a time once or twice an hour. We have a twelve-foot head-on aggregate of 500 horse-power in three turbines.

F. A. Johnson.

(b) It may shut down the whole plant.

(c) I have never known it to interfere to any serious extent with the running of a hydraulic turbine, once the rack bars have been passed by the water and anchor ice contained in it.

Clemens Herschel.

B 4. What is the lowest head under which satisfactory operation of horizontal turbines can be secured?

We find a pair of thirty-inch Leffel wheels entirely satisfactory under a ten-foot head. H. A. SPRAGUE.

Eighteen inches or two feet.

But the question arises, will it pay to do this, which is doubtful. Some such cases may, nevertheless, arise.

CLEMENS HERSCHEL.

B 5. What is the most desirable way to set horizontal turbines for operation under 30-foot head?

The locality and other circumstances concerned would greatly vary the answer to this question. CLEMENS HERSCHEL.

The instructions issued by the makers are generally the best.

F. R. SPILLER.

With a head not exceeding 30 feet, necessitating a large flow of water in second-feet through wheels, long penstocks and confined water-ways should be avoided. An excellent method under such circumstances is to place wheels in open penstock and make the power-house a part of the dam. A good instance of this setting, and one on which it would seem that excellent efficiency of the hydraulic plant should be secured, is the installation of the Spring River Power Company, Joplin, Missouri. S. R. INCH.

B 6. What methods are used to prevent racks clogging with ice where from 300 to 400 cubic feet of water are used per second?

The maximum density of water is at a temperature of 39.1 degrees Fahrenheit, and it decreases both above and below this point, so that normally, water colder than 39.1 degrees Fahrenheit rises and the formation of ice is at the top; but if the water flows over falls or rapids, or through a head race at a high velocity, the cold and warm water become mixed and the water below may be at a freezing temperature, and under these conditions anchor ice will form on the bottom and on anything with which it comes in contact. High velocity through racks will cause the same effect, and the anchor ice will cling to and close the racks. The formation of anchor ice may be reduced, and even entirely eliminated, by low velocity in forebays and racks. If the velocity in flumes is low, the anchor ice will rise to the top whence it may be carried away by a spillway, if it is practicable to use one. To avoid floating ice, a curtain wall should extend down five gate openings below. If the surface flow is swift enough, it will carry away floating ice. B. J. DENMAN.

See answers to B 2 and 3. CLEMENS HERSCHEL.

Use a boom to float the ice over the spillway. Rake the racks. F. R. SPILLER.

B 7. In a water-power plant of moderate size (about 1000 horse-power) and moderate head (60 feet or thereabouts), what is the best method of avoiding possible water-hammer in the penstock or wheel case? Should relief valves be installed or a standpipe, or both?

In a water-power plant operating under 60-foot head, the most reliable appliance to prevent water-hammer is the standpipe. If made large enough, it will never fail to work, which is not always true of relief valves. E. H. MATHER.

The standpipe is a perfectly satisfactory device for preventing water-hammer in the wheel case where circumstances permit of its installation. There is no necessity for both standpipe and relief valves. CHARLES W. COMSTOCK.

Relief valve, made by Holyoke Machine Company, Worcester, Mass. We have one 15-inch valve of this make and we never have water-hammer and our pressure never changes more than 2.5 pounds with 132-foot head and 14.5-foot draft.

THOMAS GRAY.

Air chambers, one or more, attached to penstock close to the wheel, can be made of common pipe. A standpipe will not always prevent water-hammer, unless it partakes of the features of an air chamber. Relief-valves are very good as emergency appliances. W. W. TITZELL.

Water-hammer in penstocks depends mainly on the length of the penstock. No general rule can be given. In case of large penstocks, relief-valves become impracticable.
CLEMENS HERSCHEL.

Think that a standpipe would be more reliable. A relief valve does not always work when needed. F. R. SPILLER.

B 8. Where a standpipe is installed to prevent water-hammer, is it necessary in northern climates to heat the water, or will the ordinary surging of the water in the pipe be sufficient to prevent freezing?

It has not been found necessary in Minnesota to heat water to keep from freezing. B. A. SCHAK.

We have six-foot steel feeder 1500 feet long, 4-foot standpipe on this, 500 feet from power-house; entrance of feeder at this point, 119 feet above centre of turbines. Top of standpipe is 133 feet above turbine shafts, crest of dam 132 feet above turbine shafts. Standpipe is in very exposed place on top of hill. We have never had any trouble with it. It is not covered or heated in any way. THOMAS GRAY.

I know of one standpipe in a climate where the winters are severe that gives no trouble whatever from freezing. No attempt is made to heat the water. CHARLES W. COMSTOCK.

Surging of water in pipe will not prevent the water from freezing against the sides of the pipe, which in case of long-continued cold weather is likely to injure the standpipe; perhaps burst it, or otherwise destroy it.

This is the same problem that occurs in standpipes for domestic water supply, and the only safe way is to prevent the water contained in the standpipe from freezing.

A moderate amount of heat is sufficient to prevent the water from falling in temperature below thirty-two degrees.

CLEMENS HERSCHEL.

It is necessary to heat the water in a standpipe in cold climates, to prevent the water from freezing and thus at least render the standpipe ineffective. The ordinary surging of the water, which in most stations seldom exceeds eighteen inches, is not sufficient to keep the standpipe free of ice; this is especially so during the light-load hours of the night, when the surging of the water is the least and the thermometer is the lowest. We have been entirely successful in keeping our pipe free from ice by surrounding the standpipe with a double air chamber made of matched boards lined with tar paper, and sealed at the top. In the bottom of this chamber, we use fourteen Simplex No. 5 car-seat heaters of 600-watt capacity each, and in the top of the standpipe we have a coil, circular in form, with two cross-pieces the length of the diameter of the circle, placed at right angles. This whole outfit is mounted on a hollow circular wooden float, and the same placed in the water at the top of the standpipe. Thus it can be seen that this heating coil will raise and fall with the surging of the water, and it is fastened in the top of the standpipe with No. 6 steel wires, in such a way as to prevent the coil from being thrown out in case of a discharge of the standpipe. The capacity of this coil is 2500 watts. The size of the standpipe is five feet in diameter and 110 feet high. The diameter of the heating coil at the top is about three and one-half feet.

FARLEY OSGOOD.

B 9. Are there other successful methods of transmitting power from vertical turbines to horizontal shafting besides bevel gearing? Where are they employed?

The writer knows of none. CLEMENS HERSCHEL.

Yes; it can be done by belts and by mechanical movements such as the Almond, Clemmens and others, but good, well-proportioned bevel gears are the most economical for large powers. Now, we have cut gears at very reasonable prices and they give pretty general satisfaction. W. W. TITZELL.

B 10. What are the main advantages of double-discharge horizontal turbines over centre-discharge turbines?

Question not understood. CLEMENS HERSCHEL.

B 11. What is the maximum per cent of speed variation from one-quarter load to 25 per cent overload in a water-turbine generator, and does the water consumption vary in the same ratio for various loads as the steam consumption of a steam turbo-generator?

Question not understood. CLEMENS HERSCHEL.

B 12. This winter ice has gathered on the inside of our steel penstock (which is 1600 feet long and 6 feet in diameter) during the daytime when we are shut down. Then when we begin the night run it breaks off and runs into turbines for two or three hours, making much trouble. What is the remedy?

Bury the penstock, if you can, under at least three feet of earth.

The question can not be fully answered without knowledge of the conditions and situation. CLEMENS HERSCHEL.

Should empty the penstock or cover to prevent freezing.
F. R. SPILLER.

Let a small stream run all the time. WALTER FLINT.

We have had somewhat the same trouble ourselves this winter. We are going to cover the pipe with eighteen to twenty-four inches of dirt and expect to prevent the formation of ice. We run twenty-four hours and our trouble comes on during the thaw. F. O. BROILI.

B 13. An article in an electrical journal states that increasing the grate surface will prevent ice from forming on the grates. Has anyone tried this and with what success?

In the writer's opinion, neither anchor ice nor hard ice would be prevented from forming on rack bars by diminishing the speed with which the water passes through the racks.

CLEMENS HERSCHEL.

Do not believe more grate surface will prevent the formation of ice. By increasing the area, you merely distribute the fine particles of ice over this bigger area. Have used about two square feet area per second cubic foot, and still ice collects, but less rapidly, making it possible to continue operating, as men using rakes could keep the racks clear of ice. F. O. BROILI.

B 14. Give good method of providing against the burning out of wooden step-bearings on vertical water-wheels, caused by insufficient lubrication.

In vertical wheels of large size, calling for steps with considerable area of contact, it is sometimes difficult, after bearing between metal and wood works to perfect fit, to obtain proper lubrication by water. We have found that protection against burning out the step from this cause can be practically assured by sawing a groove through the top of the step from one-quarter to one-half inch wide, depending upon diameter of the wood, carrying it down from the top far enough so that the foot of the shaft will not shut it off at the two ends even after considerable wear may have taken place.

This allows the water, at all times, to reach the surface of the step, and insures positive lubrication of all parts of the surface, when the same might not be possible without a device of this kind. It is much simpler than some plans of piping up through the step, as there is no danger of its becoming clogged or filled, and the water is sure to find its way in at all times.

L. W. EMERICK.

C—FEED WATER, ETC.

***C 1. Should wooden water tanks be painted, or how treated?**

The best treatment for staves of wooden water tanks is creosoting, if the expense be not prohibitive. Where this can not be done, thorough painting gives fairly satisfactory results, provided it is not done until the wood is thoroughly seasoned. If this latter precaution is neglected the staves will soon be ruined by dry rot. CHARLES W. COMSTOCK.

Painting is an improvement but not a necessity.
FRED. W. C. BAILEY.

After erection they should be painted with hoops loose and after painting drive hoops. The ends of the flat as well as the vertical top and bottom staves should be dipped in some kind of oil or paint and allowed to soak in as much as possible; allow plenty of ventilation at bottom of tank. GEO. W. RICHARDSON.

Wooden tanks should always be painted upon the outside, otherwise dry rot ensues, where the wood is alternately wet and dry. We have used silica graphite paint for many years (30) and have found that three good coats upon the outside of wooden tanks is a "bang-up" preserver of wood. The first coat should be allowed to dry before the second coat is applied. It dries very slowly, but one can afford to give it time as the painting with this material lasts for many years. Paint inside down to the average water line. W. W. TITZELL.

***C 2. In wooden water tanks should the heart side of the wood face in or out?**

Tank staves are better made with the heart side in. Made in this way the distortion caused by shrinkage or swelling is more uniform throughout the thickness of the piece, the stave is less likely to crack due to these changes, and the tank less likely to develop leaks. CHARLES W. COMSTOCK.

Inside, as the paint outside will better fill and protect the sap side. It will be very difficult for the average man to tell which is the heart side of the lumber, and few will take the trouble and expense necessary to make this distinction. Generally, "slap them together any old way." W. W. TITZELL.

Tank stuff should be all heart stock, cut to radius with heart side in. Cypress is best, white pine next.

FRED. W. C. BAILEY.

In wooden tanks always turn heart side of the wood inward.

H. B. JOHNSON.

C 3. Is it good practice to install a feed-water heater by-passed by a direct exhaust to the atmosphere?

Feed-water heaters need cleaning, and both feed-water and exhaust piping should be arranged in such a manner that a heater could be cut out of service without shutting down your plant.

H. M. BEUGLER.

(Practically concurrent opinions expressed by L. W. GREENE, H. A. STRAUSS, C. C. GARTLAND.)

All piping to feed-water heaters should have a cut-off valve on entering heater and be by-passed to atmosphere with some good make of back-pressure valve. Back-pressure valve should be so constructed as to allow a free exhaust to atmosphere when desired. H. B. JOHNSON.

Yes, provided exhaust is directed into heater instead of past it. This will insure the filling of heater with steam and an atmospheric exhaust. Vent heater for air with small pipe.

FRED. W. C. BAILEY.

It is good to have it there. Suppose you have three units, two for load and one for auxiliary and your heater was designed for maximum and business picked up so that the third unit was necessary for peak load instead of auxiliary or emergency use; starting this third unit would put too much back pressure on all three units, then your by-pass to atmosphere will cut down this back pressure. GEO. W. RICHARDSON.

A heater should always be so by-passed. Suppose you had no way of getting water to your feed pumps except through your feed-water heater and something should go wrong with the heater or its valves or piping. If you had no by-pass the exhaust steam might get into the feed pumps and put them out of service or it might necessitate shutting down the engine, or whatever was exhausting into the heater, altogether. If you had some other way of getting water to the feed pump you would not have to wait until the plant was shut down before you would be able to make any repairs. An exhaust to the atmosphere is always equipped with a valve between the exhaust stack and the heater and a relief-valve or some similar valve above, so it is merely a few minutes' work to cut out the heater in case anything is wrong, yet while the heater is in operation there is no chance for loss of heat to the atmosphere. A. D. BAILEY.

C 4. Give a good way to remove scale in a closed heater, by boiling with some solution or reagent, for instance, without taking heads off heater or using mechanical tools.

A good way to clean foul heaters by boiling is to use plenty of soda-ash, boil for twenty-four hours, and drain. Shut drain and put in three or four gallons of kerosene oil, then let water rise very slowly, after which let the water out, trying to keep the oil in. Repeat this operation until coating is thoroughly saturated with the oil, boil again with soda-ash and clean out the heater. H. B. JOHNSON.

A strong solution of potash (lye) will remove many kinds of scale. Kerosene oil (refined petroleum) will also loosen up scale, so also will caustic soda. These latter liquids are useful to prevent the formation of scale in boilers, and loosen that which has already formed.

We have heard that on account of the sulphuric acid in kerosene oil it is bad to put into the boiler, and we have also heard that caustic soda is bad because it attacks the iron. Any impartial chemist will tell you that there is so little sulphuric acid in kerosene oil (refined) that it will not change litmus paper, and also that caustic soda will not attack iron or steel unless in a concentrated solution.

In New York city these liquids have been used in one large office building for the past twenty-one years and it is pretty nearly time that they began to eat up these boilers. *Note:* In every case of adverse reports we have tracked them to some boiler-compound man who either had something to sell in that line or was interested. Where there is an excess of scale-producing substances in the water it ought to be put through a process of softening, which would precipitate the dirt and not permit it to enter the boiler. Keep it out of the boiler. W. W. TITZELL.

It will depend somewhat on the nature of the scale. I have used sal soda and soda ash with good results, but in time you should take out the flues and give the heater a good cleaning mechanically. L. W. GREENE.

C 5. Give compound formula for water, the impurities in which are 65 per cent calcium sulphate, 13 per cent calcium carbonate and 22 per cent other substance.

A mixture of soda ash with a small amount of caustic soda, together with a considerable amount of tannic acid in the form of catechu, should keep scale from becoming troublesome.

Quantity and proportions to be determined by experiment.
THE PHILADELPHIA ELEC. CO.

The best formula is to erect a water-softening plant or apparatus. It is not right to put water containing this amount of solid matter into a steam boiler and expect any compound to remove it. W. W. TITZELL.

C 6. Boiler feed water is impregnated with tar from a nearby water-gas plant. What effect will the tar in time have on the feed pipe, pump, valves and boilers, also on engine cylinders? And what is the best method of extracting the tar from the water?

C 7. How much heating surface is usually allowed per horse-power in a closed feed-water heater?

About one-third square foot of tube-heating surface per boiler horse-power. H. A. STRAUSS.

One-third square-foot per horse-power if the tubes are of copper, which is based on a transmission of 300 B. t. u. If brass tubes are used in the heater, the heating surface to obtain the same results will have to be increased 66 per cent. A. E. WALDEN.

Usually about one-third square-foot per horse-power when exhaust steam at 212 degrees Fahrenheit is used. It is, however, better practice to allow one-half square-foot per horse-power.
S. R. INCH.

This depends principally upon how much the owners of the plant are willing to invest in a heater. It should be governed by the water used; *i. e.,* dirty water, more surface, to allow time for the dirt to precipitate in the heater. W. W. TITZELL.

C 8. Are recording thermometers sufficiently accurate to justify their use in recording temperature of boiler feed water when thermometer is placed 100 feet from and 15 feet above point of connection on feed pipe?

C 9. Is an electrically-driven feed pump more reliable and economical than the ordinary steam-driven pump?

More economical in cost to operate where electricity can be generated at the switchboard for one and one-half cents or less per kilowatt-hour, but not more reliable; the gearing wears very fast and if belted takes up too much space. However, the items of packing and repairs on steam cylinders, *et cætera,* make the comparisons of reliability somewhat difficult to determine, especially if load is variable. F. D. SAMPSON.

Electrically-driven pump is more economical *per se,* but usually less economical in actual operation and in conjunction with the plant as a whole when the steam-pump exhaust can be utilized for heating feed water. H. A. STRAUSS.

An electrically-driven feed pump is ordinarily less reliable than a steam-driven feed pump. When exhaust steam can be advantageously used for heating feed water the electrically-driven pump is also less economical. P. JUNKERSFIELD.

In most large plants, steam-driven feed pumps are considered more economical and more reliable than electric-driven pumps, provided that the latent heat of the exhaust steam can be taken care of in a heater. THE PHILADELPHIA ELEC. CO.

D—FUEL

D 1. Where necessary to have practically smokeless combustion, is it possible to burn bituminous coal, and, if so, under what conditions of boiler equipment and firing?

It is possible to have smokeless combustion with bituminous coal, and it may be secured by the attainment of two requirements:

First. That the coal be uniformly fed into the fire, and that the volatilization of the gaseous portion be conducted uniformly.

Second. That a sufficiently large chamber back of the grate be present, so that the gases may be thoroughly mixed together and burned before passing the boiler.

The first feature—that of uniformity in feed of coal and evolution of the gaseous matter—is of the very greatest importance; for example, with a hand fire the fuel would have to be added in very small quantities, with great care, and if the fuel bed were thoroughly stirred, it would result in the evolution of a large amount of gas, which would be beyond the mixing capacity of the combustion chamber. Likewise, if a large amount of coal should be put in at one time, there would also be such a large evolution of gases that the combustion chamber could not take care of it. Or, if with an inclined-grate stoker the fuel were carelessly poked, the fresh fuel might run down in great quantity, which would produce a large amount of gas, having the same effect as under the other condition mentioned. In this connection it is well to recognize the fact that there are what may be called two kinds of smokeless furnaces; those that can be made so by careful manipulation, and those that can not be made to smoke should the operator endeavor to bring about that result. A. BEMENT.

It is possible to obtain practically smokeless combustion when burning bituminous coal if stokers are used, and it is not attempted to burn more than 25 pounds of coal per square foot of grate surface per hour.

It is also possible to obtain fair results with hand-fired furnaces if some of the so-called smoke consumers are used. These consist of a steam jet that is automatically opened when the fire door is opened to fire a charge of coal and the jet is gradually and automatically reduced after each charge is fired. The economy of this method is doubtful. B. J. DENMAN.

It is quite possible to burn even the most gaseous bituminous coal with practically no smoke by using the "Dutch oven" furnace, allowing ample space (at least 40 inches) between the grate bars and the top of the arch. In firing such a furnace, the coal should be fired in one door and allowed to ignite before any coal is fired into the other door. Care must also be taken to have ample grate area. One square foot of grate to 40 square feet of heating surface is not too much.

With coking coals, practically smokeless combustion can be obtained by coking the green coal on the dead plate and then pushing it back. H. T. HARTMAN.

It is possible to burn bituminous coal without smoke if the following conditions are obtained:

First. The gases are distilled from the coal slowly.

Second. The gases when distilled are brought into intimate contact with very hot air.

Third. They are burned in a hot fire-brick chamber.

Fourth. While burning they are not allowed to come in contact with comparatively cool surfaces, such as the shell or tubes of a steam boiler. This means that the gases shall have sufficient space and time in which to burn before they are allowed to come in contact with the boiler surfaces. WM. KENT.

Bituminous coal should be burned under an ignition arch. This method affords increased economy and practically smokeless operation, except when fires are forced or are being started. Ignition arches are used in certain stokers and in the hand-fired "Dutch oven" extended furnace. FRED. W. C. BAILEY.

In seeking to answer this question it is necessary in the beginning to make a concise statement of the cause of smoke. When coal containing volatile combustible matter is thrown on a hot fire the first and almost immediate result is the distillation of this volatile matter, which consists almost entirely of hydrocarbons. These hydrocarbons are immediately dissociated into elementary carbon and hydrogen. This dissociation absorbs heat and the temperature over the fire, therefore, falls. This fall of temperature is further assisted by the presence of the quantity of cold fuel just introduced. The drop in temperature, together with the insufficient quantity of free oxygen on top of the fire, prevents the combustion of the elementary carbon thus produced and it is carried up the chimney by the draft, appearing as "black smoke" at the top. All, or a portion, of the hydrogen may be consumed, as it is much more easily ignited than the solid carbon. The escaping carbon and such hydrogen as passes uncombined up the chimney represent two losses of heat. The first is the heat that would have been produced in the furnace if they had burned; the second is the heat absorbed from the fire by the dissociation of the hydrocarbons. As an illustration, assume that a coal contains 60 per cent fixed carbon, 10 per cent ash, 10 per cent water and 20 per cent marsh gas. The complete combustion of one pound of this coal would supply 13,500 B. t. u., neglecting the heat absorbed by the water and the ash, which would be the same in either case. Now, assume that only one-half of the marsh gas is burned, the other half simply dissociated and passing up the chimney. The heat lost by failure to burn one-half of this gas will be 2400 B. t. u. In addition there will be absorbed by the dissociating of this half 1050 B. t. u. The net heat given out by the coal is then only 10,050 B. t. u. per pound, or about 75 per cent of the theoretical value of the coal. This means a third more coal for the same work, besides the smoke nuisance.

Practically smokeless combustion may be had with bituminous coal, but not if cold fuel is distributed so as to cover the entire fire at every firing. Such coal should be fired only in the front of the fire box and pushed back over the rest of the grate only when it has become thoroughly heated and all volatile matter has been driven out of it. The combustible gases will then pass over a bed of very hot coals and the greater part of them will be burned. This is practically what is accomplished by nearly all of the over-feed mechanical stokers. My own opinion, however, is that a stoker of the under-feed type or a down-draft furnace is the most satisfactory solution of the problem.

It is safe to say that most of the smoke troubles arise either from improper firing or from an attempt to burn more coal than the furnace is adapted for, or perhaps from a combination of both causes. Office and hotel buildings operating their own power plants are nearly always insufficiently equipped and their plants are, therefore, badly overloaded. The same is frequently true of central power and lighting stations. Under such conditions no elaboration of equipment and no amount of skill in firing will secure anything like smokeless combustion.

CHARLES W. COMSTOCK.

Smokeless combustion manually is practicable with almost any condition of fuel, only under conditions where the relation existing between the steam consumption, and the capacity of the boilers is more than ample. Under such conditions, a skillful fireman will get a bed of live coals covering the grates about five or six inches thick, burned at nearly incandescence. Coal that has just previously been wet down is fired in small quantities, being dexterously spread, or it might be called sprinkled, over the fire.

When necessary to fire coal extra heavily, a jet of steam turned into the fire-box a few inches below the boiler shell is very efficacious, but this steam jet is used only under the conditions indicated.

J. R. COX.

Yes; by using preventive apparatus such as is manufactured by the Smoke Prevention Company of America, and firing light, not more than three shovelfuls at each firing. Fire doors to be opened only as short a time as possible.

W. T. OVIATT.

We burn George's Creek coal under Hazelton boilers equipped with Murphy stokers and get practically smokeless combustion.

United Elec. Lt. Co.

The essential point in smokeless combustion of bituminous coal is to arrange to coke the fuel. This can be obtained by proper and careful hand-firing or by mechanical stokers.

A very satisfactory arrangement for burning bituminous coal smokelessly is to provide the boilers with extended Dutch oven fronts, which fronts form the coking chamber.

H. A. Strauss.

Yes and no. As a chemical process it can be done, but practically in a boiler, no. Carbon from a hydrocarbon is the sole source of smoke; heated to 800 degrees or upward, it will combine with the oxygen of the air, if present in sufficient quantities, and smoke will be prevented in the furnace or consumed, if such conditions can be obtained in the combustion chamber of a boiler setting. C. C. Gartland.

It is possible to burn bituminous coal with practically no smoke by a proper arrangement of the furnace and setting. The Kent wing wall furnace will accomplish the desired result.

Geo. N. Tidd.

By building a good fire-brick arch for at least three-fourths of grate, or, in other words, build a Dutch oven; let the arch be double, with air space so constructed that air can be heated before passing over top of fire. This air must be regulated to suit the kind of coal; sometimes it is necessary to admit same volume of air on top of fire as is admitted through grate bars; feed coal in front, gradually working it back, either by hand or otherwise. Always keep ash pit doors wide open and regulate by damper.

With draft of five-eighths to three-quarters of an inch, this method will produce smokeless conditions with the smokiest kind of bituminous coal. J. Wright.

See proceedings of Society of Chemical Industry, New York section meeting of February 23, [illegible]. Editor.

D 2. What size of air openings in grates is the most advantageous when using Hocking screenings under water-tube boilers, with a stack 60 inches diameter and 150 feet high, or a draft of one-half inch?

It appears to make no difference what kind of coal, boiler or chimney is used. It is probable that the smallest openings that are used in grates are large enough to supply sufficient air for any kind of coal or for the burning of any desirable quantity. For example, the Babcock and Wilcox type of chain-grate stoker has approximately only 17 per cent of air openings, yet the writer is aware that with it as high as 69 or 70 pounds per square foot of grate per hour have been burned. Such large quantity burned was not due to any peculiarity or size of air openings, but to the fact that the coal was of a favorable size and character, so that a large quantity burned easily; but the fact that sufficient air could flow through the grate to supply such combustion, is an indication that size of openings in grates probably has less to do with such problems than is often supposed. To the writer's mind, the most important effect realized from size of openings in grates is the opportunity presented for ash to find its way thereby into the ash-pit. This is especially true with shaking grates. Resistance offered by the fuel bed or the ash and clinker associated with it, is always very much greater than that of any type of fire grate. A. Bement.

Any size that will not allow the screenings to fall through the grate. Wm. Kent.

Fifty per cent air spaces. It is immaterial whether it is water-tube or smoke-tube boiler. James Milne.

D 3. (a) What is the fuel cost per kilowatt-hour? (b) Give capacity and characteristics of station. (c) Give kind of fuel used and cost per ton.

This question can only be answered definitely for each specific case. The fuel cost per kilowatt-hour depends upon a great many factors, one of the principal ones being the load factor of the plant. A poor load factor means low electrical efficiency, consequently much greater steam consumption and hence greater fuel consumption.

In addition to the load factor, the price and kind of fuel, the type of equipment, the size of the units and the methods of operation must be known if the above question is to be answered definitely.

It may, however, be of interest to know that the fuel cost per kilowatt-hour of the largest and best designed stations in the country burning bituminous coal is about $.003 per kilowatt-hour.

If labor, water, supplies and repairs are added, the cost per kilowatt-hour in this type of station would probably be slightly less than $.0045. This, of course, includes no fixed charges.

As against this minimum, it may be stated that in small stations the fuel cost very frequently runs as high as $.016.

In ordinary railway power stations having, say, about 1500 kilowatts in generator capacity and operating condensing, with coal at $3.00 per ton, the writer has found that the cost per kilowatt-hour is frequently about $.008 for fuel.

The above may, therefore, be summed up as follows:

The cost of fuel per kilowatt-hour for the highest grade of stations in this country is about three-tenths of one cent. In average railway central stations throughout the country the cost is about eight-tenths of one cent per kilowatt-hour. In ordinary small stations, which are as a rule designed without much regard to economy of operation, the cost of fuel very frequently runs as high as one and three-quarter cents per kilowatt-hour.

All these figures are based on fuel at a reasonable price, say at an average of $3.00 per ton.

Stations operating under exceedingly abnormal conditions are, of course, not embraced in this recapitulation.

H. A. STRAUSS.

With a station capacity of 3000 kilowatts, direct-connected apparatus, compound engines, and forced draft, doing a general lighting railway and power business, with a daily output of 20,000 kilowatt-hours, with a load factor of 40, we average six pounds of coal per kilowatt-hour at the switchboard. Cost of coal per ton delivered in fire-room, $2.15. H. M. BEUGLER.

(a) Six-tenths of a cent.

(b) Capacity 950 kilowatts. Three simple Corliss engines lted to three-phase generators. Horizontal tubular boilers. ay load generally too heavy for 18 by 48 engine and not enough r next larger size, 24 by 48.

(c) Slack bituminous, at $1.25 per ton.

W. H. FELLOWS.

(a) Cost of fuel, 1.043 cents per kilowatt-hour with coal at .60 per ton. (b) Two 600-kw and one 300-kw units; four- lve, single-cylinder engines, 120 pounds steam pressure, six unds back-pressure, supplying exhaust steam to district-heat- g system. Water-tube boilers, chain-grate stokers. Load fac- r sixty per cent. Some live steam used in heating system, which included.

B. J. DENMAN.

(a) Our fuel cost is one cent per kilowatt-hour.

(b) The capacity of our station is approximately 2500 lowatts, Babcock & Wilcox boilers, Harrisburg engines, com- und-condensing, belted.

(c) Fuel used is New River bituminous coal.

W. W. FULLER.

In modern central stations using semi-bituminous coal, cost- g in the fire-room about $3.00 per ton, generating units from 00-kw up, the cost of fuel per kilowatt-hour will range from 4 to 0.5 cent.

THE PHILADELPHIA ELEC. CO.

(a) Fuel cost per kilowatt-hour=$.00793.

(b) Our peak load is about 850 kilowatts. The generators e belted from the counter-shaft, which is driven by engines of ch capacity that they are at all times carrying from a two- rds load to a 25 per cent overload.

(c) Bituminous coal, screenings from hard coal, coke eeze, and coal tar. Average cost of coal per net ton, $2.70.

DAVID W. BEAMAN.

D 4. (a) How many pounds of coal per kilowatt-hour at switchboard are consumed in members' plants—condensing, non-condensing, etc.? (b) Same for turbines. (c) Same for cubic feet of gas in gas-engine station, stating kind of gas. (d) State capacity and characteristics of station.

In a plant with an automatic high-speed steam engine and a tubular boiler and a gas engine and producer gas plant, each engine belted to a 75-kw alternator, 24-hour run, the gas engine required three to five pounds fuel, while the steam plant for the same run required 12 to 18 pounds per kilowatt-hour. The day load was very light and the average kw-hour consumption per month was about 500. The steam engine and boiler were old and not in good shape, while the producer plant and gas engine were new, put in about a year ago. Pocahontas run-of-mine was used under boiler and pea anthracite with gas-house coke, in about equal quantities by measurement, were used in th producer. S. S. Ingman.

(a) Average for year 10.8 pounds per kilowatt-hour.
(d) See answer to D 3. (b). W. H. Fellows.

8.18 pounds coal per kilowatt-hour. (d) Same as D 3 (b).
B. J. Denman.

(a) Coal consumption per kilowatt-hour at switchboard, six pounds. Plant condensing. W. W. Fuller.

(a) Pounds of coal per kilowatt-hour at switchboard, 6.14.
(d) See D 3 (b). David W. Beaman.

D 5. What efficiencies are obtained with different kinds of coal?

Coal efficiency is by no means accurately indicated by the chemical analysis. So much depends on the proportion of grate surface to heating surface, proportion of air surface to grate surface, the disposition of the heating surface, the length, area and character of the breeching, and the amount of chimney draught, that the only real criterion is a test under the existing commercial conditions.

Another factor, of much more serious importance than is generally considered, is the fireman himself. Even a very good man who has obtained his experience on one kind of coal will often make a very poor showing on another coal of quite equal merit. It is no exaggeration to say that there is a difference of 40 per cent between the results obtained by a first-class fireman and those shown by a lazy, indifferent stoker.

There is a difference between Pennsylvania bituminous coals of 10 to 15 per cent, and when the conditions are complicated by a poor fireman it is plain that astonishing results may occur.

H. T. HARTMAN.

With good hand-firing efficiencies will vary according to circumstances.

If boilers are well-designed and well set, brickwork in good condition and boilers also in good condition and not run above their rating, efficiencies may be obtained as high as 65 per cent and as low as 45 per cent. With mechanical stokers, using forced draft and making all allowances for steam used by stokers, *et cætera,* efficiencies up to 81 per cent have been obtained when using the cheapest possible kind of soft coal. JAMES MILNE.

D 6. Calling big-vein George's Creek bituminous coal 100, give the value of various kinds of bituminous coal, anthracite coal, coke and coke breeze in percentages of this figure.

For complete data on coal, see the results of United States Geographical Survey tests at St. Louis, 1904, on sixty-five car loads, samples from seventeen states. FRED. W. C. BAILEY.

George's Creek bituminous coal 100. Other kinds of bituminous coal will range from 40 to 110, anthracite 115, coke from 75 to 85, coke breeze 30 to 45. JAMES MILNE.

D 7. What are the heat values of coal used by the different companies?

The heat values of coal used run all the way from about 9500 B. t. u. per pound for the lower grades of Indiana and Illinois slack as high as 14,500 for the best Pennsylvania and Maryland coals. H. T. HARTMAN.

Majority of companies use bituminous mine-run or slack coal, ranging from the best bituminous of 14,000 heat units to Indiana or Illinois slack of 10,000 heat units.

GEO. N. TIDD.

The approximate heat values of the best of the semi-bituminous coal of Pennsylvania, can be calculated from the following analysis of some Cambria County coal:

Free carbon	71.4	per cent
Volatile matter	17.0	"
Moisture	2.0	"
Ash	8.2	"
Sulphur	1.4	"

Heat units 14,300 per pound.

First-class Pennsylvania buckwheat coal would average about as follows:

Moisture	3.0	per cent
Volatile matter	4.0	"
Carbon	77.4	"
Ash	15.0	"
Sulphur	.6	"

THE PHILADELPHIA ELEC. CO.

D 8. Give heat values in B. t. u. of gas coal, coke and George's Creek big-vein coal.

See answer to D 6. FRED. W. C. BAILEY.

D 9. Which is the more economical, run-of-mine at $2.00 or nut coal at $2.25?

We find under our conditions mine-run coal is cheaper than nut coal with a difference of 25 cents per ton. Illinois and Indiana coal used. R. N. KIMBALL.

Local conditions will govern. Run a week on each kind of al and find out by actual experience. Warren Partridge.

Run-of-mine coal at $2.00 a ton should be more economical an nut coal at $2.25, provided the draft is good and thick es can be carried. Run-of-mine coal should ordinarily be wer in ash than the nut coal, which is likely to contain con- lerable dirt. If the draft is poor and thick fires can not be rried, it would scarcely be possible to burn run-of-mine coal onomically, since the thin fires would leave large passages for cess of air to pass through the furnace, and this would ruin e economy. Wm. Kent.

With equal moisture, ash, *et cætera,* and proper grates, the n-of-mine will be more economical, assuming that no extra ndling and crushing for conveyors and stokers is necessary.
Fred. W. C. Bailey.

Run-of-mine coal at two dollars. Geo. N. Tidd.

D 10. In locations where freight on coal is from $1.10 to .30, what grade, from domestic lump to nut and slack, will nerate most steam for least money, under horizontal tubular ilers loaded to rating?

Freight on coal to Kenosha, Wisconsin, is $1.40 to $1.60. e find that mine-run gives us the best results.
R. N. Kimball.

If you have sufficient draft and grate surface, nut and slack ill be the cheapest. Geo. N. Tidd.

The nut coal would probably be the most economical under e conditions named, but this would depend somewhat upon the eat units in the slack coal of the particular mines from which al is available at the plant. A determination may be readily ade by actual trial of each grade of coal for a month or two, eping careful record of kilowatt-output and amount of coal used.

The firemen need to be carefully supervised whenever such a test is going on.
DUGALD C. JACKSON.

D 11. Quote any actual tests obtainable as to the efficiency of Roslyn, Washington, and Rock Springs, Wyoming, coal.

D 12. What is the effect of weathering on different kinds of coal?

We store La Salle third-vein lump coal, which is exposed to the weather for about three or four months. We only store the lumps, and the heating value is the same after storage as before. If we get snow or rain when freezing and it thaws and then freezes again, the coal slacks, but the steaming quality is not impaired.
LUDWIG KEMPER.

The effect of weathering on bituminous coal is to cause a loss of heating value, rapid at first, the percentage of loss lessening considerably after the first month or so, and reaching perhaps six per cent in six months.

Anthracite seems to lose very little of its heating value by weathering.
H. T. HARTMAN.

See results of tests by R. S. Hale and H. J. Williams, Transactions American Society Mechanical Engineers, Vol. XX, 1898, page 333. Different coals were exposed for eleven months and were found to lose on the average about one-half of one per cent of the total heating value as shown by Maller calorimeter. These were all eastern bituminous coals of good quality. It is possible that coals from far west, especially those high in sulphur, might show a greater loss of heating value.
WM. KENT.

Effect of weathering is not appreciable in the everyday results of a steam plant.
GEO. N. TIDD.

Seven months' weathering of Iowa bituminous coal did not show deterioration in heat value to any noticeable degree. Only change noticeable appeared in form of very slight, if any, disintegration.

Tests made in winter months. Place, Central Iowa.

R. H. Hadfield.

***D 13. How deep may soft coal be piled with safety, without providing any ventilation?**

It depends on sulphur in coal. We piled Youghiougheny coal 20 feet high and had no trouble. A coal yard next to us piled Hocking the same height and had a serious fire.

R. N. Kimball.

We store our coal (see D-12) partly in the yard, partly in the shed. We store as high as eight feet, without any special means for ventilation. We do not store the dust or small lumps, however.

Ludwig Kemper.

The depth to which soft coal may be piled with safety without providing any ventilation depends very much on the coal. Any coal that tends to crumble on exposure to air also tends to fire readily when stored. The presence of sulphur seems to facilitate this action, and coal containing any considerable percentage of sulphur stores badly. The safest way is to pile the coal not more than eight feet deep, and provide ventilation at intervals by means of old boiler tubes. It is also a good plan to have the coal siding supported by masonry or concrete piers, which separate the coal pile into comparatively small divisions.

H. T. Hartman.

Have piled Hocking Valley run-of-mine coal nine feet deep and weathered for 18 months without ventilation.

Fred. W. C. Bailey.

Depends upon the character of coal. Mine-run may be piled six feet while slack coal high in sulphur will fire, under almost any conditions of piling, in two to three months.

Geo. N. Tidd.

D 14. Can the degree of liability to spontaneous combustion in bituminous coal be determined by chemical analysis?

Yes, the higher the percentage of sulphur in the coal the more liable it is to spontaneous combustion. WM. KENT.

The degree of liability to spontaneous combustion in bituminous coal should be relative to the percentage of volatile matter contained, and can be determined by analysis.

P. H. [illegible]

Yes.

R. N. KIMBALL.
FRED. W. C. BAILEY.

Can judge of the liability to fire by the amount of sulphur contained. GEO. N. TIDD.

Its substance, or general chemical properties, does not seem to be the leading factor to its ignition. Water or excessive moisture in most cases cause spontaneous combustion of bituminous coal. GEO. W. RICHARDSON.

D 15. What style of furnace is best suited to burn coke, and what is the effect of burning coke on the brick setting?

Have burned gas-house coke with satisfactory results in a boiler designed for ordinary run-of-mine bituminous coal. Could use the coke only during the day time when the load was light, and not when there was a heavy pull on the boilers, therefore, changed to coal every evening. The only point requiring special attention was that the coke was likely to make a fire that appeared to be a good one, but was in reality only a shell, and crumbled away to nothing when the fire was cleaned.

Had no particular trouble with the brickwork.

ALEX. J. CAMPBELL.

Any style of furnace is suitable to burn coke if it has room enough to allow of a thick fire being carried. The effect of burning coke on a brick setting is the same as that with the burning of coal. The durability of the setting will depend on the quality of the fire brick. WM. KENT.

A large furnace, something on the style of the old Dutch oven, constructed in front and below a horizontal tubular boiler. Much used to burn tan bark, sawdust, bagasse and refuse fuels. Coke will destroy fire-brick walls very much more rapidly than coal fires. W. W. TITZELL.

D 16. What success has been attained by burning coke breeze and culm with the aid of forced draft?

By use of a fan giving .3-inch to .5-inch pressure under the grates, we have successfully burned breeze in four 50-hp return tubular boilers at our gas-works, getting an equivalent evaporation of 5.9 to 6.1 pounds of water per pound of fuel. We have also been able to overload the boilers 100 per cent firing breeze and using blast pressure under the grates of 8-inch water pressure. The air is distributed under the grates in ducts built in the brickwork, with openings spaced uniformly along the sides and back of the ash-pit. M. R. BUMP.

We tried burning coke breeze from Southern Kansas coal with a .75-inch natural draft. After firing about three hours the rest of the day was spent cleaning the furnace and grate-bars. W. H. FELLOWS.

The writer has burned gas-house coke breeze for several years under Heine boiler, ordinary or standard setting, and found it could not be fired in small quantities, best results being obtained with a bed from 12 to 18 inches thick. It needs little or no attention except as indicated to see that plenty of coke is on the grate-bars. The wear and tear on the setting is about the same as with coal. J. R. COX.

Good success when used in conjunction with underfeed stoker. JAMES MILNE.

D 17. Can you furnish data on methods and results of using gas tar as boiler fuel?

We have burned coal tar under one of our seven boilers for about a year with gradually improving results, due largely to improvements in the burner. We use one burner near the centre of the front of the furnace, which distributes and atomizes the tar in the shape of a fan over the grate. We burn a thin coal fire on the grate. As we burn tar only at night, we find this coal fire is necessary to maintain the heat of the furnace through the day and to start the tar at night. We have not made an efficiency test since perfecting the burner, but can say that tar makes a very hot fire. DAVID W. BEAMAN.

***D 18. What efficiencies have been attained in firing steam boilers with natural gas and with producer gas?**

Natural gas at ten cents per 1000 cubic feet as economical as coal at $2.00 per ton in bins. These figures are for West Virginia, Ohio and Indiana. LUDWIG KEMPER.

About seventy per cent of the heating value of the gas. See paper by J. M. Whitham at the last annual meeting of the American Society of Mechanical Engineers. WM. KENT.

An efficiency of sixty-five per cent to seventy per cent at full load is readily obtainable with natural gas; seventy-five per cent is reached very seldom. FRED. W. C. BAILEY.

See report United States Government, Gas producers. *Power*, January 1906. Also, *National Engineer* (NASE) Vol. VI, No. 12, December 1902.

Also, National Gas under Steam Boilers. *Power*, January 1906. GEO. W. RICHARDSON.

***D 19. What is the most economical method of generating gas for power plants?**

***D 20. In using gas as boiler fuel, what is the best arrangenent, construction, gas pressure and air dilution?**

See *Power*, January 1906. GEO. W. RICHARDSON.

D 21. Has anything been done in this country, outside of nunicipal plants, in the use of garbage as fuel?

D 22. What is the best kind of coal-handling apparatus?

The best kind of coal-handling apparatus for plants of 500 orse-power or less, is the old-fashioned wheelbarrow. For arger plants, up to those using 40 or 50 tons of coal per day, mule and cart will generally be found more economical than oal-handling apparatus. H. T. HARTMAN.

In small stations, say up to 100-kw capacity, the best way f handling coal is probably by one or several coal chutes delivring coal directly on boiler-room floor in front of the furnaces r by industrial truckage carried parallel with the furnace fronts f the boiler upon which charging cars are run. The latter arangement, if provided with siding, enables the fireman to charge irectly from his car to the furnaces, utilize the empty cars for aking up ashes, shunt this ash car on the siding and proceed ith his charging operations from the next car. This latter rrangement also frequently does away with the necessity of any xtra labor during the night, as often a sufficient number of cars an be loaded and placed on the track in the boiler room to carry he station through the night, thus cutting down the labor item. his industrial trackage arrangement also enables the boiler-room oor to be maintained clean at all times.

For larger stations, say up to about 3000-kw generator caacity, mechanical stokers charged by hand are probably most atisfactory, as stations of this size show a marked reduction in ost of labor when mechanical stokers are used.

For stations above this size, and where the extra cost of uildings to carry overhead bunkers is not objectionable, the ost desirable arrangement is, of course, mechanical stokers suplied by chutes connected to overhead coal bunkers, forming part of the building proper and carrying a considerable storage of coal. For these stations the use of mechanical stokers and overhead bunkers undoubtedly results in a considerable reduction of the labor item.

An arrangement somewhat less elaborate than the last described, which does away with the frequently objectionable feature of large cost of building construction, is to provide a traveling coal bunker, which may be moved along and parallel to the fronts of the boilers. This traveling bunker gathers up its coal by a self-contained conveyor and is moved along electrically to charge the several stokers.

Every station, however, requires individual study to determine the coal-handling apparatus that is best adapted to its specific requirements. H. A. STRAUSS.

There is no single type of coal-handling apparatus that is best for all conditions. FRED. W. C. BAILEY.

D 23. What is the average cost of coal-handling per ton? State conditions.

Coal unloaded from car direct into boiler-room, five cents per ton. R. N. KIMBALL.

It costs us about four cents per ton to unload coal from car to furnace. The method is as follows: By means of a locomotive crane, coal is taken from the car and deposited in the crusher. From crusher the coal passes by means of a conveyer to the magazines over the boiler. UNITED ELEC. LT. CO.

Average cost of handling buckwheat coal from barges with endless chain bucket, varies from 2.5 to 3 cents per ton, including trimming in boat. When bituminous coal has to be shoveled into buckets in same barge, the cost will possibly vary from 8 to 11 cents per ton. When coal is dumped from car into hopper, total cost of handling [illegible] conveyed by coal apparatus and trimming [illegible] 3 cents per ton.

THE PHILADELPHIA ELEC. CO.

In a plant handling fifty to sixty tons of coal per day and hand firing, the cost of getting the coal in from stock, firing and removing of cinders, should not exceed thirty cents per ton.

GEO. N. TIDD.

D 24. What is the comparison of B. t. u. per pound in Pennsylvania bituminous and English Welsh coal?

The B. t. u., per pound, by calorimeter, are 14,415 for Pennsylvania bituminous and from 14,600 to 16,214 for Welsh coals; however, the Welsh coals are almost pure anthracite. The Newcastle has 14,820, Derbyshire and Yorkshire 13,860, Scotch 14,164; these are bituminous coals. F. D. SAMPSON.

Pennsylvania bituminous about 12,800 B. t. u.
Welsh bituminous about 14,800 B. t. u. A. PETERS.

D 25. Give comparative values of coal and oil for boiler fuel.

In a discussion on smoke prevention at a meeting of the New York Section Society of Chemical Industries, the following figures were given as determined by the Standard Oil Company:

Oil at 20 cents a barrel is equivalent to coal at 65 cents per ton; at 40 cents a barrel, to coal at $1.49 per ton; at $1.06 a barrel, to coal at $3.26, and at $2.06 per barrel, to coal at $6.52 per ton. EDITOR.

The best grade of coal has a calorific value of from 14,500 to 15,500 B. t. u., while crude oil has values varying from 18,500 to 20,000 B. t. u. In burning oil under a boiler more economy may be had than in burning coal, for (1) a pound of oil has more heat units than a pound of coal, and (2) with oil we can obtain more nearly perfect combustion. When an oil fire is properly handled no smoke will be emitted from the stack. On analyzing the flue gases given off from an oil fire, carbon monoxide (CO) is rarely found, while in a coal fire from one-half to three per cent is usually prevalent. The presence of CO is evidence that a great many heat units are being wasted, since the formation of CO from carbon and air is but the first stage of combustion, only one-fourth of the heat units being given up. SAMUEL KAHN.

Some California crude fuel-oil in use contains 18,500 B. t. u. per pound, all of which is consumed, leaving no appreciable residue.

High-grade coal may contain 14,000 B. t. u. per pound of combustible.

Knowing the relative costs per pound of the two fuels, the comparison is easily made.

Burning oil as fuel has, however, many other advantages, such as reduction of cost of building and stack, the elimination of all coal and ash-handling apparatus, and very decided reduction in boiler-room labor. H. A. STRAUSS.

D 26. What is the best method of preventing coal-storage fires in bituminous coal, and what is the best method of putting out same when once started? Coal is stored out of doors on the ground and is leveled off at a height of 12 feet.

By providing sufficient ventilation. Construct a nozzle as per diagram below, drive pipe into the coal pile to get beyond the layer of coke which forms over the coal, then turn on the water. By throwing water on the outside of the pile, the water does not reach the fire, but runs off over the layer of coke.

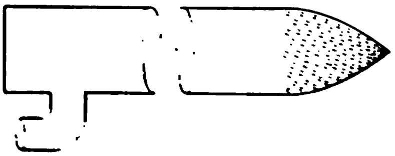


DIAGRAM OF NOZZLE

F. R. SPILLER.

E—BOILERS AND MECHANICAL STOKERS

E 1. (a) What success have you had with superheating boilers? (b) Do superheating boilers work well in multiple with other boilers? (c) Would you advise independent superheaters instead of superheating boilers to supply superheated steam to turbines?

(c) Superheaters forming part of the boiler proper are undoubtedly liable to cause boiler shut-downs and are also objectionable from the fact that the degree of superheat can not be controlled. In general operation of turbines, however, the control of the degree of superheat is not very important.

A separately-fired superheater, with its piping so arranged that it forms a shunt to the main steam header, enables the operator to supply either saturated or superheated steam, or a mixture of both, at will to the system, also does not necessitate the shutting down of boilers when the superheater proper is causing trouble; it furthermore enables the degree of superheat to be controlled to a nicety. If there is plenty of room, and the slightly greater cost is no objection, the separately-fired superheater represents the most desirable installation. H. A. STRAUSS.

(b) Superheaters work all right in multiple with other boilers.

(c) All modern practice tends to omit separate superheaters and place superheating coils in boilers.

DUDLEY FARRAND.

Universal practice in this country and Europe indicates that superheating boilers are highly successful. Much depends on conditions of plant and type of boiler. Superheaters in vertical boilers appear to be more efficient than in horizontal boilers. The objection of superheating boilers has been heretofore one of deterioration of the superheaters. There are at present several standard makes of superheaters that have proved durable and efficient.

From the results of various tests a gain of from 10 per cent to 11 per cent per 100 degrees superheat is observed in steam consumption of turbines, the gain being practically the same at all loads. Superheat usually used in American turbine practice ranges in neighborhood of 100 degrees to 150 degrees Fahrenheit. Out of 40 turbine plants ranging from 2000-kw to 4000-kw 34 used superheat between 100 degrees and 150 degrees Fahrenheit. This range is easily within limits of various forms of apparatus suitable for mounting within the boiler setting of nearly all boilers.

In most cases superheating would be more economical and just as efficient as independent superheaters. K. W. ALGER.

E 2. (a) Are internally-fired boilers—Morrison type—satisfactory for electric-power plants? (b) Will they stand forcing for peak loads? (c) Why are they usually "leaky"?

Internally-fired boilers are not satisfactory for Illinois and Indiana coal, on account of the limited furnace room and grate surface. (b) Depends on kind of coal and amount of grate surface. (c) Internally-fired boilers have slow circulation; the bottom is often cold when the boiler is under steam. In some vessels circulating pumps and pipes are used.

R. N. KIMBALL.

(a) I have found internally-fired boilers, with Morrison furnace, very satisfactory for pressures above 125 pounds, and that they may be forced to carry peak loads. All boilers of this class should be covered with at least two inches of asbestos, or some other heat-insulating substance.

(b) Boilers of this class usually show leaks when fired from cold water, owing to unequal expansion: but if the shell plates are of the proper thickness, properly riveted and calked, there is no reason why the boiler should continue to leak.

L. W. GREENE.

E 3. In a station of 5000-kilowatt capacity or less, has the mechanical stoker shown any actual economy in labor or fuel as compared with hand-firing? If so, how much?

Stokers would probably not effect any saving in ultimate cost, as boiler-room labor could not be reduced and the fixed harges, maintenance and repairs would undoubtedly offset any aving in fuel that could be effected. If it is necessary to abate moke, stokers might be justified. B. J. DENMAN.

In a station of this capacity the mechanical stoker will un- oubtedly show considerable economy in labor but hardly any conomy in fuel. H. A. STRAUSS.

Experience has shown that mechanical stokers are economical 'here the plant uses not less than 50 tons of coal per week.
DUGALD C. JACKSON.

E 4. In an electric light plant of about 400-kilowatt capac- ;y, using soft coal screenings at $1.25 per ton, would it be an lvantage to install mechanical stokers?

A plant of 400-kilowatt capacity would not have a load ictor of over 50, and under these conditions no saving could be iade. R. N. KIMBALL.

(Practically concurrent opinions expressed by C. C. GART- ᴀND, B. JAMIESON, GEO. N. TIDD, E. H. MATHER.)

Our experience is that mechanical stokers do not pay in lants smaller than 1000-hp capacity. The labor and fuel sav- ig in such plants is not usually sufficient to pay repairs, iterest and depreciation on stokers. LUDWIG KEMPER.

There would be no economy in installing mechanical stokers ı a plant of 400-kilowatt capacity with coal at $1.25 per ton. Inless the plant is large enough so that it is possible to save ı labor by the use of stokers, it is questionable policy to install iem, as first-class hand firing is very nearly, if not quite, equal ı the best results obtained by stokers. H. T. HARTMAN.

It can be considered without much question of doubt that a plant as named, with soft coal screenings at $1.25, it would ɔt be advantageous to put in mechanical stokers unless a method of mechanical firing was necessary owing to the quality of the coal. WM. B. JACKSON.

The writer believes that it would undoubtedly be a mistake to install a mechanical-stoker equipment under these conditions, so far as any gain in reduction of cost of labor or fuel is concerned. The only advantage would be an easing of the strain on the fireman as against a considerable additional fixed charge.
H. A. STRAUSS.

E 5. What type of mechanical stoker is best for small central station giving a 12-hour service?

It would almost certainly be a mistake for such a station to install any type of mechanical stoker.
H. T. HARTMAN.

We think the Murphy stoker is as suitable as any for a small or large station. THE UNITED ELEC. LT. CO.

The writer's answer to question E 4 will also serve for his answer to this question. H. A. STRAUSS.

E 6. (a) What detail methods of firing have been adopted to secure smoke abatement? (b) State conditions under which same were applied.

With the Kent wing wall furnace and the alternate method of firing, firing not more than four shovels at a time and only one half of the furnace, right and left hand alternately. Spread the coal in a thin layer each time. Be careful not to fire any fresh coal until the gas has been burned out of the coal on the side previously fired and the coal on the other side has been burned down so low that there is an excess of air passing through it. WM. KENT.

See answer to D 1. H. T. HARTMAN.

(a) The alternate spreading method of firing will largely abate smoke. One-half of the furnace is fired at a time and very light, and the coal thoroughly spread. In this way the high furnace temperature is maintained which will in a large measure consume the smoke. GEO. N. TIDD.

One method, which can be used in hand or mechanically-fired furnaces, is to mix with the bituminous or semi-bituminous coal a portion of the smaller sizes of anthracite, from fifteen to twenty-five per cent. With careful firing, practically smokeless combustion can be obtained in this way.

THE PHILADELPHIA ELEC. CO.

The Dorrance furnace, in the Rookery building, Chicago.

J. WRIGHT.

E 7. Give type of smoke consumers that have produced good results, stating boiler conditions under which same were installed.

The Kent wing wall furnace is the best smoke consumer we have ever tried. It shows a considerable gain in efficiency over the ordinary setting, while smoke consumers of the steam jet type, and those depending on the creation of gas, combustible at low temperature, by the spraying of oil, show no increase in economy, although some of them consume the smoke.

H. T. HARTMAN.

With the wing wall furnace almost absolute abatement of smoke has been obtained. WM. KENT.

Two Murphy furnaces under each 400-hp three-drum Babcock and Wilcox boiler installed at the Northwestern Elevated power station, Chicago, Ill. J. WRIGHT.

E 8. What is a reasonable expenditure for boiler compound per horse-power-hour?

Two cents per 100-boiler horse-power per day (24 hours).

B. J. DENMAN.

Any expenditure for "boiler compound" is unreasonable. If the feed water is bad it should be analyzed and the chemist should prescribe the substances to be used in purifying by their regular commercial names, such as soda-ash or milk of lime. The use of secret preparations known as "compounds" savors of quackery.

Wm. Kent.

The cost of boiler compound per kilowatt-hour varies with the quantity of the water used. In a 4000-kilowatt high-efficiency plant, using fairly good feed-water direct from the river, the cost for boiler compounds varies from 1.5 to two cents per 1000 kilowatt-hours.

The Philadelphia Elec. Co.

E 9. Using hard water, is it possible to keep boiler tubes absolutely clean by use of proper compound, or does a compound allow a thin scale, one-sixteenth inch or less, to form and merely keep it soft? Briefly, what is the best result one can expect under these conditions?

The best a boiler compound can do is to soften the scale so that it can be blown out periodically. The water contains the same amount of scale-making impurities per pound whether the compound is used or not. If the water is evaporated into steam, the scale-making materials are left behind, where they either bake fast to the exposed surface or are blown out.

H. T. Hartman.

Using Lake Michigan water we keep our boilers clean with compound and washing them once in two weeks.

R. N. Kimball.

Fortunate to keep scale soft if water is very hard.

B. J. Denman.

Have a competent chemist analyze the water and if it is unfit for boiler use have a simple softening-plant erected and treat the water chemically before it enters the boilers. There are many such plants in use. On the Newark meadows water is pumped from the river and put through the softener and it does not make any hard scale. Also pump from artesian well in salt meadows. At the Harrison Steel Works, another softener plant is working satisfactorily. Do not put dirt into boilers; catch it outside. It can be done. Some of the compounds now used are highly injurious and attack the boilers, make screwed pipe-joints leak, stick piston rods, valve stems, and pump plungers.

W. W. TITZELL.

E 10. What would be considered fair fuel economy over a month of regular operating work when burning bituminous coal in a hand-fired furnace, and under similiar conditions what should it be if the same grade of fuel were fired on a chain grate?

There would be no fuel economy. H. A. STRAUSS.

A chain grate usually wastes a great deal of fuel by the fuel falling through the bare grate just under the hopper; and there is also a loss of grate surface, as the fire does not burn close up to the front as is the case in hand firing upon a stationary or shaking grate. We should expect the best results from the hand firing. W. W. TITZELL.

E 11. What is the best stoker for horizontal tubular boilers of 125 horse-power each, say, for a battery of four boilers?

E 12. Why are mechanical stokers sometimes discarded after being installed?

They are labor-savers, not fuel-savers, and their operation involves considerable maintenance cost. If the conditions do not justify mechanical-stoker equipment the equipment will probably prove unsatisfactory. H. A. STRAUSS.

Generally for high cost of repairs, also on account of the skilled labor required to operate the stokers. F. R. SPILLER.

Mechanical stokers have in some cases been installed in plants that were too small to gain economy from their use, and in other cases they have not been properly cared for and have run down, resulting in dissatisfaction. In other cases the prejudice of the operating men has resulted in improper operation of the stokers. Such reasons as these have been the fundamental cause of discarding good types of mechanical stokers that have once been installed. Where mechanical stokers of a good type are installed in plants of suitable size and are properly operated their advantages are too apparent to permit them to be discarded. DUGALD C. JACKSON.

E 13. What are the comparative advantages of motor and steam drive for automatic stokers in a light and power plant?

E 14. How should a 60-inch by 18-inch return tubular boiler be set and cared for so as to maintain tight brickwork?

Set the boiler on expansion rollers under back lugs, line arch full length with good fire-brick, build at least 20-inch walls, put on not less than three sets of binding bars.

L. W. GREENE.

E 15. What composition in fire-brick will best stand the heat and abuse common to a boiler furnace in a large generating station, without cracking or running too freely? Where is such a clay found?

Support boiler on steel columns, allow brickwork to dry at least 30 days before firing, and then fire for at least 48 hours with a very slow fire. Fire-brick around furnace should be thoroughly wet and dipped in a very thin mortar so as to lay very close. Brickwork and furnace constructed in this manner will last for years without separating or cracking or having to be repaired.

A. E. WALDEN.

E 16. What is the general experience in the use of chain grates with anthracite coal?

Very wasteful of fine grades of fuel and needs more grate surface to do an equal amount of work. W. W. TITZELL.

E 17. Our power-house is located at tide water. We have 2000-hp Stirling boilers equipped with "Tread-kill" shaker grates, 150 x 8-foot steel stack, natural draft. At times, when all conditions are apparently unchanged as to load, feed water, coal, etc., it is impossible to hold steam, while as a general rule it is no trouble. What is the cause and its remedy?

Under certain conditions shaking grates are used to burn pea coal. If the fires are shaken when firing pea or buckwheat it will be almost impossible to hold the steam. As this question does not state the kind of coal burned or the draft conditions, it is hard to answer properly. Would suggest draft gauge and noting atmospheric conditions at time of trouble. A. E. WALDEN.

E 18. What is the usual cause of burned-out tubes in water-tube boilers?

Poor circulation, due to poor design and scale formation. Heavy overloads for long periods. D. J. FERRY.

Scale formed inside so that the water could not come in contact with and protect them. Sometimes steel tubes are used in place of charcoal iron. The former will not stand with certain waters, will pit, corrode, groove, and so forth.

W. W. TITZELL.

E 19. What is the comparative economy and efficiency of the Parker water-tube boilers and the Babcock and Wilcox water-tube boilers?

There should be practically no difference. It may be stated in general that there is very little difference in the efficiency of any two good makes of boilers. H. A. STRAUSS.

The Parker boiler has no water in the bottom rows of tubes and therefore will not stand much forcing, as these tubes will burn out, while the Babcock and Wilcox boiler has a good body of water in it. We should expect the Parker to give dry steam, but it would of necessity be shorter lived and require greater care than the Babcock and Wilcox. W. W. TITZELL.

E 20. Would a foaming boiler give any bad results if not attended to in proper time?

Likely to damage boiler and engine. D. J. FERRY.

E 21. Is there a steam-jet blower smoke consumer on the market that is economical and that consumes the smoke?

F—FORCED DRAFT, BLOWERS, STACKS

F 1. Has reinforced concrete in which broken fire-brick was used ever been tried for boiler-flue construction?

Yes, but in this case whole fire-brick would have been much cheaper. Difficult to get the broken fire-brick, more so than to get whole bricks. W. W. TITZELL.

F 2. What is your opinion of a boiler flue constructed of ferro-inclave iron coated on the inside with concrete composed of broken fire-brick and cement, and on the outside with plastic magnesia covering?

Very good. FRED. W. C. BAILEY.

Rather expensive, and cement would not be likely to stand the test. J. H. Gautier's fire-brick or terra cotta lumber laid in Gautier's fire-clay would be far preferable. We mention J. H. Gautier's clay because it comes from a special clay bank and has been known for years as a most durable material. These bricks are not smooth nor handsome, but they do stand a tremendous heat without injury. W. W. TITZELL.

F 3. (a) What is the life of a steel self-supporting stack, 60 inches by 120 feet high? (b) Used in the middle western states should a stack of this kind be lined or unlined?

(a) The life of a self-supporting steel stack depends more on the thickness than on the diameter and height. In a case that recently came under my notice three-sixteenths-inch steel plates

: corroded to such an extent by four years' use that it was ssary to renew the stack. This is, of course, unusual. The of an unlined iron stack is sometimes as high as 8 or 10 s.

(b) In the middle western states a stack of this kind should ıinly be lined, as the coal used contains so much sulphur the life of an unlined stack is quite short.

H. T. Hartman.

(a) We have a steel self-supporting stack about 60 inches 20 feet high; this stack has been in service for 10 years, and is apparently as good as when first built; it has been painted : times.

(b) The above stack is lined; we also have one not lined. climate here is specially severe on iron, but both stacks apparently last for a great number of years to come.

W. W. Fuller.

(a) I know of several self-supporting steel stacks that have in use for more than 10 years and do not appear, after ful inspection, to be seriously deteriorated. If well built and carefully painted, there is no reason why they should not last ır 50 years.

(b) I do not believe there is much advantage in lining ‹s. The draft may be slightly increased by prevention of ation, but this increased draft may be more cheaply obtained n increase in height. Charles W. Comstock.

(a) Have, myself, taken down steel chimneys built of quarnch plates at the top, that were reduced to slightly more than :ighth of an inch in thickness, and had been in service but years. The reduction appeared almost entirely on the inside.

(b) It will prolong life of stack if thoroughly red-leaded lined. Edison Ill'g Co. of West Chester.

(a) If properly painted and inspected from time to time, e should be no difficulty in getting fifteen years of satisfactory ice from this stack.

(b) The stack should be lined at least half way to the top, and the writer believes that the slight additional cost entailed by lining the stack to the top represents a good investment.

H. A. Strauss.

(a) Life depends on gauge of metal and whether lined or unlined, and on amount of sulphur, *et cætera,* in fuel.

(b) Should be lined. Fred. W. C. Bailey.

(a) About ten years if properly painted and maintained.

(b) Such a stack should be lined. Ernest F. Smith.

Seven to eight years. Andrew F. Hall.

***F 4. In erecting a riveted steel boiler stack made up of short sections, should the opening made by the laps between individual sections face up or down, and why?**

Although it is common practice to erect riveted steel stacks, which are made up of short sections with the laps opening upward on the inside, this is a mistake. First, because the combination of deposit and rain water that runs down the inside of the stack and into the lap is far more destructive to the metal than the pure rain water that may run down the outside of the stack and inside of the lap when the laps open upward on the outside of the stack; second, unless extraordinary precautions are taken in the making of the joints, rain water in combination with the deposit upon the inside of the stack will run through the laps and down the outside of the stack, quickly destroying its good appearance. For reasons above stated, it is far better to have the stack erected with the laps opening upward on the outside, and there appears to be no good reason why it should be erected otherwise. Wm. B. Jackson.

A riveted steel stack should be composed of slightly conical sections with the large ends *down.* If placed the other way the upper edges of the plates form little shelves on which dirt and moisture accumulate and the plates rust badly at these places. On the inside this accumulation of moisture is not to be feared.

Charles W. Comstock.

(Practically concurrent opinions expressed by H. T. Hartman, R. H. Hadfield, H. W. DeV., Westchester Ltg. Co.)

For lined stack, each section should be built slightly conical with lower end of each section fitting outside of upper end of next lower section, providing an effective water shed. For unlined stack, use the reverse, as the rain will not wash soot through joints to outside. Most stacks are built of straight sections, every alternate section fitting inside of the section above and below, which are made slightly larger.

FRED. W. C. BAILEY.

If the joints in a steel stack are made to face upward, the water from rain-storms will run down inside of chimney.; if reversed it will run on outside and make the chimney have a streaked, dirty appearance at all times. As for durability of the chimney, it makes little difference how the laps are put on.

EDISON ILL'G CO. OF WEST CHESTER.

Small end should be at bottom. Seams will last longer and stack look better, as rust will not run down sides.

ANDREW F. HALL.
C. C. GARTLAND.

***F 5. Have you ever calculated the chimney draft by formula and checked it with actual observation by thermometer and draft gauge? Give figures.**

Formulæ for this purpose are not very accurate; better measure it with a draft gauge. W. W. TITZELL.

F 6. What is the most reliable formula or method of figuring the size of chimney for plant, having given: size of boilers and number, average kind of coal to be used? Same for cases where both chimney and fan are used?

No formulæ can be entirely relied upon in figuring the size of a power chimney of important dimensions, but a good deal of judgment must be used in applying the formulæ which are of common use. The inquirer can get information regarding formulæ from the book entitled *Chimney Design*, by Christie.

DUGALD C. JACKSON.

F 7. What are the advantages, if any, of reinforced concrete chimneys over those made of brick, tile or steel?

There is no advantage over brick except lower cost. Concrete will, however, show much longer life and lesser maintenance cost than steel.

H. A. STRAUSS.

F 8. Has anyone had sufficient experience with forced and induced draft, as applied to chain grates, to say what effect each has on boiler efficiency and capacity?

F 9. Are best results obtained by having automatic damper regulators control a single damper in main flue or a set of dampers in individual boiler flues?

In large plants having many boilers, it seems the best practice to have a damper regulator to control the dampers in the main flues rather than to control the individual boiler dampers.

THE PHILADELPHIA ELEC. CO.

F 10. What experience have members had with the McLean balanced draft system of the Engineer Company, of New York?

G—PIPING, CONDENSERS, ETC.

G 1. What is the best pipe-joint packing in steam lines having temperature of 550° F., pressure 150 pounds?

If flanges in steam lines are accurately faced, good results can be obtained by using a wrought-iron ring turned on each side and finely ringed with lathe tool after facing, or by cutting an annealed-copper ring from 16-oz. sheet copper. In either case make the ring with the same inside diameter as flange and an ıtside diameter that will just go inside of flange bolts. Draw ıe joints together evenly with the bolts, not permitting one de to crush the packing ring before the other is brought up.

Edison Ill'g Co. of West Chester.

So far as the writer knows, there is only one pipe-joint ıcking on the market that will prove satisfactory for this work. his consists of a metallic core surrounded by flexible composi-ɔn. This particular packing has been known to give thor-ıghly satisfactory service on plants operating with 200 pounds 'essure and 200 degrees of superheat above the temperature of is pressure.

H. A. Strauss.

The best gasket in steam lines of high temperature and press-e is one composed of copper and asbestos, the copper and bestos each taking one-half of the width of the face of the gas-t.

In steam lines where there are high pressures and high tem-ratures, a plain asbestos gasket is good, provided there is very tle water in the lines.

H. W. DeV., Westchester Ltg. Co.

A good corrugated copper gasket, using white lead when ;talling, makes the best joint.

H. B. Johnson.

We use the Van Stone joint and Kearsage packing.

United Elec. Lt. Co.

Corrugated copper gaskets.

Fred. W. C. Bailey.
B. J. Denman.

Corrugated copper or corrugated annealed sheet steel.

Benjamin F. Shaw Co.

G 2. What type and make of valve will best stand super-:ated steam?

Valves for superheated steam should be made of steel or steel ›mposition.

Dudley Farrand.

Chapman Valve Manufacturing Company makes a special gate for superheat and New Bedford Boiler and Machine Company makes special globe and angle valves. Both types have been proven very efficient. BENJAMIN F. SHAW Co.

G 3. What and how much is the benefit to be derived from the use of a dry vacuum pump in connection with a barometric jet condenser?

With a dry vacuum pump, less water will be required for a given vacuum; the amount of water can be adjusted to the load on engine instead of pumping maximum amount at all times; it can be speeded up, and ordinary air leakage can be taken care of without lowering vacuum; it will remove air and other non-condensable vapors which condenser-head will not take care of, and thereby increase your vacuum. It is a desirable and paying investment. FRED. W. C. BAILEY.

The dry-vacuum pump in connection with barometric jet condenser will generally reduce amount of circulating water required by fully forty per cent, other things being equal.

H. A. STRAUSS.

The benefit derived by use of a dry-vacuum pump in connection with barometric condensers depends on the type and condition of the condenser. Barometric condensers of the injector type will not be benefited enough, as a rule, by a dry pump to warrant its use. There are other types where a dry-air pump is necessary. F. C. CLARK.

Can get a greater vacuum with a smaller supply of water.

D. J. FERRY.

G 4. In figuring steam piping, what is the most reliable formula or means of figuring the size of pipe, having given: pressure at boiler and engine, distance to be carried, horse-power of engine or turbine? Also size of main in case x number of engines are to be supplied from the main?

Take sum of combined area of all outlets and nine-tenths of id amount equals the area of the steam-main desired.

BENJAMIN F. SHAW CO.

G 5. Describe reliable methods for taking care of expansion steam pipes?

A "U" bend. A telescope joint is good if pipes are anchored joint will not pull out. D. J. FERRY.

Copper bends. Steel bends will do but take more room.

WALTER FLINT.

The best method of taking care of expansion in steam pipes nsists in the free use of steel bends of short radius, or in eaking up the line into short lengths.

THE PHILADELPHIA ELEC. CO.

The most reliable method for taking care of expansion in eam piping is by anchoring the pipe at convenient points and etween these points introducing a loop, semi-circular or double S" in shape, the bends to be as large as possible in radii. nchorages should make the pipe absolutely rigid at the anchoring oint, and the supports of the anchor should be made, if possible, part of the steel structure. If only a brick wall is available, e strain of the anchorage should be transmitted through a long ngth of the wall by means of steel angles, or channels, bolted rough brickwork. At all supports of the steam header, saddles hould be used with rollers that will permit a free movement of the iping in the direction of its own length.

THE BROOKLYN EDISON, G. L. KNIGHT.

G 6. What is the best expansion joint for use on a 50-foot traight run of 10-inch steam main carrying 150 pounds pressure? he joint to take care of contraction and expansion when steam is urned on and off about three times per week.

A copper bend, or, if there be room enough, a steel bend. on't use the stuffing-box type; they expand all right but are ot inclined to return to the original position.

WALTER FLINT.

Should use a "U" bend. D. J. FERRY.

For a 50-foot 10-inch steam main carrying 150 pounds pressure there would be very few conditions in which the use of any expansion joint would be desirable, as there should be no difficulty in arranging the connections so as to permit of the very slight expansion movement that would be had in such a pipe. Under ordinary circumstances this pipe would simply be anchored in the middle and allowed to expand in either direction from the anchor. WM. B. JACKSON.

The Wainwright improved expansion joint, consisting of a main corrugated tube of soft copper, an inner cylindrical slip-tube of hard copper or composition: external and internal equalizing rings of cast iron and connecting flanges of cast iron and steel. BENJAMIN F. SHAW CO.

G 7. State briefly the principle of the barometric condenser.

A column of water enclosed in a tube closed at upper end. The lower end being submerged the water will fall until atmospheric pressure is sufficient to support it. Column will create a vacuum at closed end of tube. If upper end of tube be opened air will enter and column will fall, but if sufficient water be supplied at upper end to maintain the water at a level the air will be drawn in continuously and, mingling with the water, will be discharged at the bottom of the tube. Connecting upper end of tube to exhaust of engine instead of opening it to the air, the exhaust steam will be carried up, mingle with the incoming water, be condensed and fall with the water down the long tube.

A. PETERS.

G 8. What is the best method of determining the size of exhaust piping in cases where it is necessary to place the condenser at a considerable distance from the engine or turbine? What allowance should be made for elbows, both long and short turn, and what velocity of steam is allowable in such cases?

Exhaust pipe should be full size from engine to condenser.
BENJAMIN F. SHAW CO.

G 9. Which is more frequently installed in large plants, he surface or the jet condenser?

The jet condenser; because in most cases there is plenty of ater and where there is plenty of water and reciprocating enines are used it is best to waste both the condensed steam and ie injection water, whereby all danger of putting oil back into ie boilers is avoided. If surface condensers are used with recipocating engines it is generally due to the fact that boiler feed ater is scarce or salt water is used for condensing purposes. Jet ondensers are cheaper.

For operation with steam turbines the surface condenser is ore often used, because it is easier to maintain a high vacuum id the condensed steam from the turbine may be put into the oilers without fear of oil. H. A. STRAUSS.

When feed water is cheap, a jet condenser. When feed water high, a surface condenser. D. J. FERRY.

Surface condensers are more generally used than jet conensers. They cost more originally and require more condensing ater, but they possess the advantages of allowing only the conensed steam to return to the boiler; therefore, any water, no atter how impure, may be used for condensing.

S. C. FOSTER.

G 10. In a surface condenser, owing to the resistance of the st of tubes, there is unavoidably a difference in vapor pressure tween the point where the steam enters the condenser and e point where the dry air is removed. How low should this fference in pressure be in a well-designed condenser when opering at rated capacity?

G 11. An 800-kw railway unit having a cross-compound rizontal Corliss engine running at 80 r.p.m. is provided with jet condenser, the water supply of which is controlled by a am-driven centrifugal pump located at bottom of condenser's ne. There is also an independent steam-driven air-pump. A hutte-Koerting light-pressure backwater valve is located between gine exhaust and condenser. Variations in load cause this

valve to knock violently with every stroke of the engine. What is the reason and what is the remedy?

G 12. Give some good practical applications of the steam accumulator (Rateau, for instance) and give reasons for same based on actual results.

G 13. How often should injector be tested to be sure it is working properly?

Not less than once a week. DUGALD C. JACKSON.

Test at least twice in twenty-four hours.
BENJAMIN F. SHAW CO.

G 14. Vibration of engine probably starts leaks under bolt-heads of flanges. What is the best way to stop it?

Guy your steam pipe to prevent vibration.
L. W. GREENE.

Resetting valves in engines sometimes stops vibration. Increasing sizes of steam mains.

Placing receiver or receiver-separator, the cubical contents of which will be equal to contents of cylinder, near throttles.

Placing long-sweep bends instead of elbows in leads to engine. BENJAMIN F. SHAW CO.

H—ENGINES

***H 1. Compare cost of steam-engine, steam-turbine and gas-engine installations; itemized if possible?**

A recent estimate on a producer-gas-engine, steam-turbine and steam-engine lighting plant, complete, of 2750-kw capacity, with 25 per cent overload capacity of units, 37.5 per cent load factor, 24-hour service, and high-grade construction throughout, totaled $122 per kilowatt for gas; $88 for turbine, and $91 for reciprocating engine. On a 5000-kw railway plant with 66 per cent load factor, the gas-power plant totaled $118 per kilowatt and the steam-engine plant about $89. With $3.50 coal, the net saving per year, including all fixed charges, amounted in the former case to 16 per cent over steam, and in the latter considerably more.

owing to higher load factor. The excess cost of the gas plant is thus soon wiped out in the latter case in about three years.

J. R. BIBBINS.

There is very little difference in the cost of installing a first-class compound-condensing steam plant with water-tube boilers and a suction producer-gas plant of the same size; local conditions might make either of these the more expensive.

S. S. INGMAN.

See paper on *Power Plant Economies* read before the American Institute of Electrical Engineers, January, 1906. Abstracts of this paper appeared in *Electrical Journal,* February, 1906, p. 106, and *Electrical World,* February, 1906, p. 144.

B. J. DENMAN.

H 2. With conditions identical, is a fast or a slow-speed engine more economical?

If this question calls for a comparison between automatic or high-speed engines and Corliss type or low-speed engines, there is no question but that the low-speed is far more economical.

If, however, the question applies to low and high-speed engines of the same type, the high-speed engine is more economical; only, however, on account of the reduction of fixed charges as represented by the lower investment. In general, there is very little difference, the main gain being in the considerable reduction of cost of the generator for increase of speed.

H. A. STRAUSS.

A slow-speed engine with automatic steam cut-off valves will be more efficient than high-speed engine. H. B. JOHNSON.

Slow-speed. C. D. W., N. Y. ED. CO.

ANDREW F. HALL.

***H 3. In gas-engine practice, what simple devices are there that will give the engineer some idea as to whether the proportion of gas and air is such as to give the greatest economy?**

Use an indicator and note time of ignition and expansion time, and get a combination that will give you the highest initial pressure. H. M. BEUGLER.

Indicator test will show this.

C. K. N., N. Y. Ed. Co.

An experienced engineer, if he is within sound of the engine, will readily detect any material variation in the mixture, but some means of indicating this condition at a distance would be of service.

S. S. Ingman.

In most gas-engine plants this is accomplished by opening a small cock on the cylinder head and noting the relative force of combustion with different mixtures. In this manner it is easy at any time to find the best mixture. Some operators can even tell by the sound of the suction when the proper mixture has been obtained.

J. R. Bibbins.

***H 4. What is the best way to determine the weight of the fly-wheel in designing a gas engine, in the case of an engine direct-connected to a generator, where the speed must not vary more than two per cent from no-load to full-load?**

The function of a fly-wheel is to equalize the motion whenever the power communicated or the resistance to be overcome is variable. In one case where the fly-wheel is used to overcome a variable resistance, it may be considered a conservator of power; in the other case the fly-wheel may be said to be a distributer of power; consequently, as a regulator of motion for the gas or steam engines the weight and diameter of fly-wheel must depend upon the work and character of the machinery it is intended for, so that in proportioning a fly-wheel to a given engine, attention must be paid to many particular circumstances rather than to any given rule. The effectiveness of the fly-wheel in steadying the motion of the engine depends upon the distance of the metal from the centre. For this reason the material of which the fly-wheel is composed should be concentrated as much as possible in the rim. The steadying action varies also as the square of the speed of the rim. Hence, within certain limits increasing the diameter saves weight. Considering the safe rim-feet per second, use following rule for finding the weight of a fly-wheel, having the size of cylinder, the diameter of the wheel and the revolutions per minute: First, multiply area of the piston by the length of stroke in feet. Multiply this product by constant 12,000,000. Second, square the number of revolutions, multiply this by the diameter of the wheel in feet. Divide the first by the second and the quotient is the proper weight for the fly-wheel in pounds. C. C. Gartland.

***H 5. What are the causes of the recent reversion from vertical to horizontal gas engines?**

The horizontal gas engine is easier to get at than the vertical, especially when the gas and air valves are located so that it is necessary to climb to a platform to reach them, the crank-case bearings in such case being more likely to be neglected on account of their inaccessibility. Splash-oiling from the crank case is far from being the best means of lubrication, and the multiplicity of bearings to the crank shaft increase the liability to trouble. Tandem cylinders are preferable to side-by-side cylinders.

S. S. Ingman.

Strictly speaking, there has been no reversion to horizontal gas engines, as vertical engines are widely used, mostly of the single-acting type. The horizontal design presents many good features leading to greater stability, rigidity of structure, lower cost of construction. More especially is it adaptable to the tandem-cylinder arrangement that has proven desirable in large double-acting engines where two power strokes per revolution are desired, such as is the case in driving alternating-current generators for parallel working. J. R. Bibbins.

H 6. What is the best efficiency known of any type of steam engine from the coal pile to the switchboard? Ditto, steam turbines.

Steam-engine plants rarely get below 3.5 pounds of good coal per kilowatt-hour generated, even in railway plants with high load factors. Steam-turbine plants are considerably more economical, running down to a minimum of 2.5 pounds on good coal. Producer-gas engine plants easily outstrip steam plants on the score of economy. A small industrial plant near Buffalo, of less than 500-kilowatt capacity, equipped with vertical three-cylinder single-acting gas engines, has been giving 24-hour service for the past eighteen months on less than 2.25 pounds of bituminous coal per kilowatt-hour guaranteed. With the average load factor, at present about 55 or 60 per cent, the coal consumption is even lower—close to two pounds per kilowatt-hour, and at times on heavy load the plant has run on 1.8 pounds per kilowatt-hour, corresponding to about 1.15 pounds per brake horse-power-hour average through the day. J. R. Bibbins.

H 7. Will engines govern as closely under variation of steam pressure as under variation in load?

Properly-designed engines with sufficient fly-wheel capacity should govern more closely under variation of load than under variation of steam pressure. F. D. Sampson.

No. The speed will drop more for a decrease in steam pressure than for an increase in load. This is especially true of a compound engine running non-condensing. H. D. Larrabee.

No; creeping steam pressure is the most difficult for a governor to handle. L. W. Greene.

No. F. R. Spiller.

H 8. Will a stationary engine pull the same load as well running under as running over?

It is a matter of design of the engine. In running under, the cross-head will exert by far the greater pressure against the upper guide bar, which may not be strong enough to stand it. If it is, and any other parts against which the pressure is reversed are also of sufficient strength, the engine should run as well one way as the other. The maker of the engine should be the one to answer this question. W. H. Thomson, Jr.

There should be no difference, although it is unusual to see one so operated. Some authorities claim undue wear on upper side of guides. F. D. Sampson.

Yes; but it will be necessary to keep the cross-head tight to prevent hammering. H. D. LARRABEE.

No difference. F. R. SPILLER.
WALTER FLINT.

H 9. What are the allowable pressures per square inch in engine bearings, cross-head pin, crank pin and main bearing?

It is usual practice to allow 125 to 150 pounds per square inch of projected area, though this varies in the type and make of engine. A. E. WALDEN.

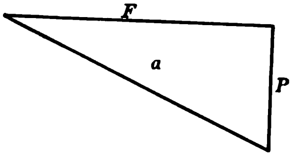
H 10. How can you determine the pressure on the guides of a horizontal engine for a given position of the cross-head?

Indicate the engine and note the effective pressure for the given position of the cross-head. This pressure per square inch times the effective piston-area in square inches give the total horizontal push or pull in pounds. Knowing the position of the cross-head gives at once the position of the crank which determines the angle made by the connecting rod with the horizontal.

Then suppose:

P=pressure per square inch for given position of the cross-head. A=effective area of piston in square inches. Then F, the total horizontal force, is equal to PA. Let the line F represent the horizontal force and A the angle made by the connecting rod with the horizontal. Then P, the pressure on the guides, is equal to F tangent a.

Another method of getting the same thing is to take a plumb line up from the centre of the crank-pin for the given position of the cross-head, measure the distance from the centre of the crank-pin to a horizontal line through the centre of the cross-head, and measure the distance along the horizontal line from the centre of the cross-head to the point vertically above the centre of the crank pin. The vertical distance will then be represented by the line *P* and the horizontal distance by the line *F* in the diagram below:



Then the pressure on the guides will be *F* times the vertical distance divided by the horizontal distance. H. D. LARRABEE.

H 11. Give information in regard to successful parallel operation of alternators driven by gas engines.

Two 500-hp Westinghouse heavy-duty gas engines of the horizontal double-acting type are operating the entire urban and interurban system between Warren, Pa., and Jamestown, N. Y. Owing to the small number (3) of heavy (35-ton) interurban cars in service at any one time, the heavy grades and sharp curves, the variation of load on the engines is extremely violent, yet they are handling this load without any troubles from alternating-current parallel operation or other causes. Expenses for fuel are about seven cents per car-hour average. A dozen or more plants of from two to five units of the vertical single-acting type are operating successfully in parallel on various classes of power service. J. R. BIBBINS.

H 12. If a gas engine and producer can be installed at so low a cost as is claimed, can be run so economically and regulated so closely, why are not more large gas-engine-driven units installed?

The builders of large gas-engines (1000-hp up) have demonstrated conclusively that their guarantees in fuel consumption and regulation are within reason. But the question of maintenance and its increased cost over steam, which in some cases exceeds the saving in fuel, with the factor of interruptions in service considerably enlarged, robs the proposition, as a whole, of its golden hue. But, notwithstanding this condition, gas producers in connection with gas engines are possessed of real merit and before the proposition is thrown to one side it deserves a thorough investigation. H. M. BEARDSLEY.

Because first cost is considerably greater; because fuel is only
rare cases so high in this country as to warrant the additional
vestment; because high-grade gas engines have only recently
n this country) been placed on the market. H. A. STRAUSS.

This question probably refers to suction producer plants in
nall sizes. Popular prejudice and cheap fuel are largely re-
onsible for the comparatively slow advancement of the gas-
gine art. High cost of fuel is forcing the adoption of gas
wer. J. R. BIBBINS.

Small producer-gas engine economy and regulation are mostly
n the old country" or on paper, at this writing.
L. W. GREENE.

**H 13. What would be the cost of a 500-hp gas producer
ected?**

**H 14. For a lighting plant in small towns of 1500 to 3000
xed population, have gasolene engines used as prime movers
roved successful? How do the plant investment and the economy
operation compare with those of the usual steam-engine plants?**

No; some gasolene engines operate fairly well, but the cost
gasolene prohibits their use.

Oil engines are perhaps more economical, especially the
ude-oil engine. However, producer gas and a good gas engine
ill best fulfil the requirements. W. W. FULLER.

Gasolene engines are unreliable. L. W. GREENE.

**H 15. How long are gas engines capable of operating con-
nuously without abnormal deterioration?**

A 650-hp Westinghouse engine of the vertical three-cylinder
ngle-acting type has a record of forty days (twenty-four hours)
ninterrupted run under a load of gas compressors with abso-
tely no mishap or evidences of undue deterioration. A small
gine of the same type has run 1157 hours, or over forty-eight
ys, without stopping, and a total of 8230 hours with but 0.6 per
nt shutdown.

In a 500-hp pumping plant on the Alleghany river each gas-
gine unit regularly operates from 96 to 98 per cent of the
apsed time. J. R. BIBBINS.

H 16. What net efficiency is obtainable in every-day operation from (a) gas engines and (b) producer power plants of moderate capacity as compared with steam?

(a) A high-grade gas engine will show 24-25 per cent efficiency at full load; a steam engine of similar character 15-18 per cent.

(b) A 450-kilowatt producer plant using bituminous coal and Westinghouse engine gives an average net plant efficiency of 13 per cent at two-thirds load factor, and has given 15 per cent efficiency under heavier load.

The average steam plant operates under 10 per cent; probably from 7 to 8 per cent. A 40,000-kilowatt railway plant in New York city operating on 66 per cent load factor has given 10.3 per cent efficiency. J. R. Bibbins.

H 17. How does the cost of power compare with gas and steam?

Vide reports below on largest gas power plant in London compared with steam plants in vicinity doing same service.

OPERATING COSTS*

London Metropolitan Boroughs

	Plant Cap'y Kw	Output Sold Kw-Hrs	Ratio Sold Gen per cent	Load Factor per cent	Operating Cost—d Kw-Hrs. Generator					
					Fuel	Supplies**	Labor	Repairs***	Works or Operating	Total††
Average of 11 steam plants†	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.214	.218	1.058	1.41
Walthamstow	[illegible]	[illegible]	[illegible]	15.45	[illegible]	.152	.288	.048	0 856	1.05
Saving per cent in favor of gas					[illegible]	**	−13.5	+78	+21.5	+25.4
Operating expense items—per cent of works cost steam plants					55	8.4	13.6	20	100	129
Operating expense items—per cent of works cost gas plants					[illegible]	17.8	33.6	5.6	100	123

* [illegible]

** [illegible]

*** [illegible] system.

† [illegible] Hammersmith, St Pancras.

[illegible]

†† [illegible]

[illegible]

[illegible] J. R. Bibbins.

I—TURBINES

I 1. Will the De Laval steam turbine of 50 to 100 horsepower replace a modern high-speed engine satisfactorily and show a gain in economy?

Yes, with proper pressure.

C. K. N., N. Y. Ed. Co.

The De Laval steam turbines claim to and actually do compete with Corliss compound engines in their economies and general performance. C. D. Chasteney.

I 2. What advantage has the 500-kilowatt turbine over the 500-kilowatt engine where the question of space need not be considered?

Flexibility. C. K. N., N. Y. Ed. Co.

The most important advantages of a properly designed 500-kilowatt turbine over a reciprocating engine, in cases where floor space is not important, are that its care and maintenance will involve much less expense, and that its efficiency at light load and overload will, under favorable conditions, be decidedly better; the efficiency of reciprocating engines falls rapidly with overloads, while that of a 500-kilowatt turbine will generally be maintained or will improve to a point of high overload. This affords better economy and greater overload capacity with a given steam supply. W. L. R. Emmet.

The economy of a 500-kw or any other size of steam turbine over a reciprocating engine of similar capacity is not only governed by the type of apparatus compared, but is also almost wholly governed by local conditions. Eliminating the saving in space and the attendant saving of interest and depreciation on the investment in building and land resulting from the saving of space, there would result savings in the cost of equipment, installations, attendance, oil, repairs, renewals and depreciation; and the further the load factor departs in either direction from designed full load, the greater we should expect the saving to be in the cost of water and fuel. In fact, there is no item of either first cost or operation that should, under any conditions, be greater with a properly-selected and properly-installed steam turbine than with the same selection and installation of reciprocating engine. There is every reason to expect a saving on most items and a strong possibility of a saving on every item of cost connected with the purchase, installation and operation. Therefore, local conditions govern the degree of saving, and this question can not be answered specifically. CHAS. B. BURLEIGH.

Probably the only advantage that a turbine of this size has over a reciprocating unit of the same size is the reduction in the cost of foundations. H. A. STRAUSS.

Five hundred-kilowatt turbine has the advantage of a 500-kilowatt engine in simplicity of operation; absence of large number of moving parts; reliability of operation; overload capacity; increased economy. GEO. N. TIDD.

Outside of the unquestioned lower cost of lubrication and repairs, this question is distinctly "up to" the operating man. The following extract from the *Marine Review* admits, though under protest, the points at issue:

THE RECEEPROCATIN' MON.

Oh, waesome 'oor that saw the birth
O' turbine thochts in Pairsons' heid;
I weesh that I wis aff the earth,
Or else the turbine men wis deid.

I'm a receeprocatin' mon;
I luve tae hear the bearin' bump,
Or yet the piston groan and grunt
That's relegated tae a bloomin' pump.

This whurligeegin' thing I hate,
For whutna gude is it tae dae?
Tae sae the fearsome thing gyrate
Gars me piur stummuck glang aglay.

I widna care if it had ocht
  Tae heed a tender fitter's haund,
But it rins sae weal sin it was bocht,
  I hivna had tae slack a glaund.

I hate the tribe o' whurligeegs ;
  It's jist a pinch o' steam, then "Scatt."
I'm a receeprocatin' mon ;
  I stann or fa' wi' Jeemie Watt.

(Robert Burns and others, including Gavin Hamilton.)

J. R. Bibbins.

I 3. Can a steam turbine be operated on the back pressures ncountered in good steam-heating practice, with the same econ- my as a good reciprocating engine of the Corliss or four-valve ype?

The steam consumed by a Curtis turbine working down to e atmosphere will generally be about twice as much as that hich it requires with a good vacuum. With saturated steam e consumption will range from about 32 to 40 pounds per lowatt-hour with turbines of different sizes and speeds. The n-condensing steam economy of the best turbines is probably ightly inferior to that of the best compound reciprocating en- nes at full load. Since the turbine costs much less to operate d maintain, and since steam economy is generally not important here steam is used for heating, it will never be advantageous use a reciprocating engine instead of a turbine for this pur- se.

W. L. R. Emmet.

Few reliable data regarding actual economies while oper- ing under back pressures, but from data obtainable regarding eir general performance after continuous service, would not sitate to favor the turbine because of its essential simplicity.

C. D. Chasteney.

Two Parsons type turbines are operating satisfactorily in strict heating plants in the Middle West, notably at Columbus. the turbine is not especially designed for non-condensing work will probably show a higher water rate than the steam engine installed for this purpose, but as it is frequently desired to run condensing during the warm weather this is not an undesirable feature. A Westinghouse-Parsons turbine designed for non-condensing work has shown water rate as low as 23 pounds at full load with atmospheric back pressure.

FRANCIS HODGKINSON.

Steam turbine can not be operated with the same economy as reciprocating engine upon back pressure.

GEO. N. TIDD.
FRED. W. C. BAILEY.
C. D. W., N. Y. ED. CO.

I 4. What troubles, if any, have been encountered in running turbines of the horizontal type against pressures of 16 to 20 pounds absolute; also of the vertical type, and if remedied, how?

In order to get good efficiency from a steam turbine there should be as good a vacuum as possible on the exhaust side. If the back pressure mentioned is from heating system and parties wish to operate steam turbine it would be better to install enough radiating surface in system to make an atmospheric condenser out of heating system, such as the Pall or Johnson system. H. B. JOHNSON.

Apparently, no serious troubles have been experienced, except the demands on the coal pile. FRED. W. C. BAILEY.

No trouble should be experienced in running a horizontal turbine against this pressure, but an inspection of any turbine steam-consumption curve will show that the steam consumption when running against such pressure is about double what it would be for condensing operation, therefore requiring practically double boiler capacity for the same output.

H. A. STRAUSS.

I 5. Quote any actual tests made on a Parsons steam-turbine station running condensing, giving the coal consumed per hour when operating with no load with generator at full voltage only. State steam pressure and number of auxiliary engines in use.

The coal consumption of a station running idle is so largely affected by methods of handling fires, and by station losses outside of the turbines, that any data along this line would be worthless. The 1000-kw Westinghouse-Parsons turbine tested by the National Electric Light Association at Hartford required 2684 pounds of water per hour running light and 20,000 pounds per hour at a little over full load. J. R. BIBBINS.

I 6. In operating a Parsons steam-turbine station condensing, quote actual results, giving pounds of coal consumed per hour per kilowatt-hour recorded at the switchboard.

A 2000-kw Westinghouse-Parsons railway turbine plant in Ohio shows 2.99 pounds Ohio slack per kilowatt-hour on turbine plant alone; about four pounds with 50 per cent additional plant capacity in reciprocating engines. J. R. BIBBINS.

I 7. What temperature of superheated steam gives the best results on a Curtis turbine?

Curtis turbines have been operated successfully with as much as 250 degrees of superheat, and with the later types of valve mechanism there will be no trouble caused by superheat even in this high degree. The actual fuel saving accomplished by superheating is a much disputed point, and the evidences relating to this subject are very contradictory. From theoretical considerations it seems probable that there is appreciable economy with superheating. The gain in water rate of a turbine with 100 degrees of superheat amounts to about seven per cent and the rate of gain is about uniform from no superheat up to about 200 degrees. Recent investigations concerning total heat of superheated steam indicate that steam of 175 pounds' pressure and 100 degrees superheat carries from four per cent to five per cent more heat units than saturated steam of the same pressure. Very elaborate and perfect investigations recently made at Munich give the latter figure, which leaves rather a small margin for gain by superheating, even with the most perfect apparatus.

W. L. R. EMMET.

The Curtis turbine is adapted to the use of any degree of superheat and the steam consumption is reduced as the superheat is increased. Other results, so far as the Curtis turbine is concerned, are not affected by superheat. The Curtis turbine benefits in economy from superheat of as high a temperature as can be obtained up to a point where the fuel necessary to produce it does not represent a cost in excess of the saving effected.

CHAS. B. BURLEIGH.

I 8. Which is better for use on the stepbearing of a Curtis turbine—water or a first-class oil?

In a Curtis turbine there is more or less leakage to the step bearing, so that if oil is used it soon has so much water mixed with it that an emulsion is formed, which is a very poor lubricant. Therefore, if oil is used, a cheap grade is quite as good as first-class oils. H. T. HARTMAN.

Water has recently been adopted in connection with step-bearings and lower steady-bearings of many vertical-shaft Curtis turbines, on account of the inconvenience in handling oil and maintaining a vacuum packing, which is necessary where oil is used. The operation is in most cases as good with water as with oil, but in several cases the change has caused trouble. The thickness of step-bearing film is less, the cushioning effect of steady-bearing is less, and there is consequently less margin for imperfections of balance and alignment. All machines are so constructed that oil can be used if for any reason water is found to be undesirable. W. L. R. EMMET.

The best lubricant for the step-bearing of a Curtis turbine is a good grade of mineral oil. This should not be too heavy in viscosity, and if too light would approach the defects of the low viscosity of water. A film of oil will preserve a bearing from oxidation as well as from wear. FLORUS R. BAXTER.

Water; as in the remote possibility of excessive friction the water will vaporize, leaving absolutely clean surfaces, while under e same conditions oil would carbonize, and carbon, being exemely hard, would tend to result in vicious cutting.

Chas. B. Burleigh.

Water. F. R. Spiller.

I 9. Which gives better results on the stepbearing of a rtis turbine—oil cooled by water coil or oil not cooled and used a temperature of 160 degrees?

Oil at 160 degrees Fahrenheit will be just as satisfactory as lubricant for step-bearings and lower steady-bearings as cooler l. If the oil were allowed to rise to the boiling-point of ater, as it would if operated non-condensing without a cooler, s lubricating effect would be very much reduced, but it would esumably be still a better lubricant than water which is used ccessfully in many cases. W. L. R. Emmet.

Oil is supplied to bearing surfaces for two reasons: First, reduce friction, and, second, to conduct away the heat occaoned by friction. An oil that answers the second purpose should kept at such a temperature as will best serve its purpose on e bearings. As the oil increases in heat it loses its viscosity d where it may have an ample factor of safety at 100 degrees, e same oil used at 160 degrees would have a considerably naller factor. Florus R. Baxter.

There being no metallic friction in the step-bearing, the temrature of the lubricant is of no moment so far as the bearing is ncerned. Chas. B. Burleigh.

Oil cooled by water coil. D. J. Ferry.

I 10. Has a Curtis turbine in which water is used on the ep-bearing been known to go down on the step?

I believe there have been a number of cases where the stepearing has gone down on the step, but it does not seem to ave been followed by any serious results. In fact the turbine was started without any change whatever and has been running ever since. Using an accumulator of sufficient size, there is very little excuse for such an accident. H. T. HARTMAN.

There have been a good many cases of step-bearing failures with water lubrication. All of these presumably arise from imperfection of alignment or balance, or from too great clearance in some of the shaft bearings. W. L. R. EMMET.

A number of instances are known where the two blocks in the step-bearing of the Curtis turbine have come together on account of the failure of the water pressure, without serious result. In one instance, it was not even known that the blocks had come together until at a later date when the step-bearing was taken down for examination it was seen that the surfaces had been rubbing. I. E. MOULTROP.

The pressure has been destroyed in the step of a Curtis turbine many times with little or no bad effect; in fact, the step blocks are surfaced in position by running at a low speed without lubricant. CHAS. B. BURLEIGH.

I 11. Are the blades, and discs holding same, in Curtis turbines stiff enough to prevent rubbing when heavy fluctuations in load occur?

The material from which the blades of a Curtis turbine are milled is of greater width than the blades when completed; under no conditions, therefore, can the blades come in contact with anything other than the actuating fluid.

CHAS. B. BURLEIGH.

The blades of discs of Curtis turbine have, in our experience, been amply stiff to prevent rubbing during heavy fluctuations of load. THE PHILADELPHIA ELECTRIC CO.

We have been operating Curtis turbines on a combined railway and lighting load, and in the past fourteen months have had no trouble with blades and discs. T. H. T. & L. Co.

I think so. Have two turbines in use and experience no rouble. RALPH R. LAXTON.

I 12. (a) Have members ever heard of the striking of the uckets of a Curtis turbine? (b) How do these buckets wear in se?

(a) It is a physical impossibility for the Curtis buckets to rike.

(b) I have inspected the buckets of a 600-kw Curtis turbine at has been in continuous operation for some five years and have ailed to discover any evidence of wear.

CHAS. B. BURLEIGH.

We have never heard of the striking of the buckets of the urtis turbine, properly erected. (b) Wear on buckets with dry team seems to be *nil*. THE PHILADELPHIA ELECTRIC CO.

I have not. Buckets seem to wear well.

RALPH R. LAXTON.

I 13. In steam-turbine practice how high should the vacuum maintained to secure the best economy of operation?

To secure the best economy with a steam turbine, as with a ciprocating engine, the vacuum should be perfect. Of course is is out of the question in either case, but, as the turbine and nnections present less opportunity for air leaks, it is possible to aintain a higher vacuum than with a reciprocating engine and e turbine benefits from it in economy. It is comparatively a nple matter to maintain with a Curtis turbine a vacuum resultg in from one to two inches absolute back pressure in the ndenser. CHAS. B. BURLEIGH.

Depends to a large extent upon quantity and maximum temrature of cooling water available and type of turbine, 27.5-inch referred to thirty-inch barometer) has proven quite suitable in arsons-type turbine plants and comparatively easy to maintain. n tide water, or other large bodies of water, or with artesian ells, a higher vacuum can easily be maintained at such small crease in cost that it is usually found profitable. J. R. BIBBINS.

The steam turbine is especially adapted for giving good results with a high vacuum. It is usually economical to maintain the vacuum at, say, 28.5 inches when referred to a thirty-inch barometer. An exception to this, or reason for lower vacuum, would be a condition when cost to maintain vacuum is extreme, due to high temperature or unusual lift of circulating water.

P. JUNKERSFIELD.

We understand that vacuum should not be less than twenty-six inches to secure good results. We have in our turbine plant been able to maintain vacuum of twenty-eight and twenty-nine inches, and have with 500-kw turbine secured coal consumption of 4.5 pounds per kilowatt-hour and with 1500-kw turbine 3.5 pounds per kilowatt-hour, using Indiana bituminous slack coal.

T. H. T. & L.

All things considered, at twenty-eight inches referred to thirty-inch barometer. H. A. STRAUSS.

Not under twenty-six inches. C. K. N., N. Y. ED. Co.

I 14. Has experience in the operation of steam turbines indicated the necessity or desirability of having a mechanical brake, water rheostat or other means of stopping the turbines?

This is a point that has never been raised except in connection with the Curtis vertical-shaft turbine, and while a brake was originally designed for the purpose of bringing this machine to rest, it was abandoned, as it has generally proved satisfactory to leave the field on, on removing load and shutting off steam and breaking the vacuum. CHAS. B. BURLEIGH.

I 15. What is the comparison in steam consumption per indicated horse-power of steam turbines and reciprocating engines, both of same capacity, being operated under the same conditions, with varying loads?

From the fact that it is impossible to obtain a steam diagram from a steam-turbine, there can be no comparison of steam conumption per indicated horse-power; it must be estimated. As he output of the turbine can to-day be used only through the gency of an electric generator and the interest of this association n it is wholly from an electrical point of view and as its interest n the engine is and has always been from the same point of iew, it would seem more equitable that comparisons and guarntees on prime movers for electric stations be made on the asis of the relation that the input bears to the output. The inpu s steam measured by weight and the resulting output is electricity neasured in watts. For the reason that it is extremely difficult, if ot impossible, to obtain reliable figures under the same conditions vith varying loads, I do not think figures to answer this question re available. It is particularly difficult to obtain these figures t a fixed load, but the writer is familiar with a recent test n New England where a reciprocating engine and Curtis turbine were tested on the same load, boiler-pressure, superheat and vacuum, and the turbine economy was 18 per cent better than that of the engine. CHAS. B. BURLEIGH.

Good engineering would not countenance operation "under he same conditions" because, all things considered, a condensing eciprocating engine operates most economically at 26 inches vacuum (30-inch barometer) and a steam turbine at 28 inches vacuum (30-inch barometer). H. A. STRAUSS.

Indicated horse-power of the steam turbine can only be obained by assuming its efficiency as corresponding with mechancal efficiency in reciprocating engines; thus, assuming a very verage figure of 90 per cent efficiency, a medium-size turbine (Westinghouse-Parsons type) would give a water rate of 11.9 pounds per i.h.p.-hour on saturated steam and 10.5 pounds per i.h.p.-hour on moderate superheat. J. R. BIBBINS.

I 16. What is the difference of economy between a reciprocating engine, "Atlas" type, and a Curtis turbine, 5000-kw units, t their normal load; also the difference in pounds of steam between ormal and light loads?

I 17. What is the known difference in efficiency of the station where reciprocating engine exhausts direct into condenser and that where the reciprocating engine exhausts into low-pressure turbine, which then exhausts into condenser?

I 18. Has the vertical-type turbine any material advantage over the horizontal type in the matter of compactness? How do they compare in modern turbine stations?

Per se, the vertical turbine has some advantage in the matter of net floor space, but usually requires more actual floor space on account of the extra area required for the installation of numerous auxiliaries.

HORIZONTAL (PARSONS) TYPE

Name of Plant	Square Feet/Kw Station	Square Feet/Kw Operating-Room*
Metropolitan District Railway, London....	1.31	.563
P. N. Y. & L. I. R. R....................	1.37	.595
Philadelphia Rapid Transit...............	1.19	.506
Brooklyn Rapid Transit...................	.817	.326
Average..................................	1.169	.497

VERTICAL (CURTIS) TYPE

Name of Plant	Square Feet/Kw Station	Square Feet/Kw Operating-Room*
Chicago Edison...........................	1.88	.77
Boston Edison............................	2.64	1.04
Average..................................	2.26	0.905
Difference in favor of horizontal type......	1.091	0.408
Difference in percentage of horizontal type.	93%	82%

* "Operating-Room" includes ground floor area of switch-room.

The greater compactness of the horizontal turbine plants is mostly due to the more effective location of auxiliaries in the basement, so that no extra floor space is required. J. R. Bibbins.

I 19. In a turbine plant where surface condensers are used, is it possible so to arrange the plant that condenser can be installed directly beneath the turbine without taking up extra floor space

or head room? What is the extra cost for surface condensers installed beneath turbines?

Only in the horizontal type is this possible. It is necessary to elevate the vertical turbine the depth of the condenser to accomplish this result. For the horizontal turbine, no extra cost; with the vertical turbine, the condenser shell has to be made strong enough to bear the entire weight of the turbine unit, and is also divided into two compartments to provide central access to the step-bearings. FRANCIS HODGKINSON.

I 20. Are any of the modern type turbines suitable for mounting on structural foundations?

Several Westinghouse-Parsons turbine plants are operating with structural steel or iron pipe column supports. One station is now building in which turbines are installed on second floor above boilers; their weight being carried by the building framework. J. R. BIBBINS.

I 21. Is high vacuum or superheat necessary to obtain good economy in the Parsons type of turbine?

Neither are necessary, on account of the low steam velocity employed in this type of turbine; fairly-high vacuum is, however, generally recommended, because it is a paying investment and costs less to obtain and control than does high superheat.

FRANCIS HODGKINSON.

I 22. Quote some certified tests on Curtis and Parsons turbines running on saturated steam; (a) on high vacuum 28 or 29 inch, (b) low vacuum 25 or 26 inch. State vacuum.

A 500-kw Westinghouse-Parsons turbine tested by Ludwig and Company, engineers, Atlanta, Ga., gave the following water rates with saturated steam and about full load:

28-in. vacuum........13.68 lbs./b.h.p.-hr. = 19.3 lbs./kw-hr.
26-in. " ....14.91 " " = 21 lbs./kw-hr.
24-in. " ....15.86 " " = 22 lbs./kw-hr.

J. R. BIBBINS.

I 23. Why are some builders of turbines so much in favor of high superheat and vacuum, and others not?

Because the losses from fluid friction, with the high steam velocities employed, may be largely reduced by evaporating the moisture in the steam and by working the low-pressure stages in the most rarefied atmosphere possible. J. R. Bibbins.

I 24. In an emergency, how much time is necessary to erect and put into operation a turbine unit?

A 1,000-kw Westinghouse-Parsons turbine unit was erected in two days and was in service within seven days from the beginning of erection, the delay being caused by non-completion of station piping. J. R. Bibbins.

I 25. Where crane facilities are at hand, how much time is necessary for dismantling a steam turbine so that the rotor may be removed?

A Westinghouse-Parsons turbine of moderate size has been shut down, dismantled, and the rotor removed for inspection, in less than one hour. The machine was again assembled and put into operation in about an hour and three-quarters.

Francis Hodgkinson.

I 26. What is the longest continuous run on record for a turbine plant?

A [illegible]-kw Parsons type turbine has a record of 17,300 hours' (over [illegible]) practically continuous run under official seal, with no deterioration noticeable when seals were removed. Another [illegible]-kw turbine (Westinghouse-Parsons) ran [illegible] hours continuously at the Louisiana Purchase Exposition. J. R. Bibbins.

I 27. Is it possible to prevent air leakage around shaft of a steam turbine?

The only way to absolutely prevent leakage through packing glands is by the employment of some form of fluid-packed gland.

such as the centrifugal water gland used in the Westinghouse-Parsons turbine. FRANCIS HODGKINSON.

J—DISTRICT HEATING

J 1. Does district heating by hot water pay when there is not enough exhaust steam to take care of entire load?

It depends on location and prices received for service. In general, you must have nearly enough steam or you can show no profits. R. N. KIMBALL.

It usually pays to install sufficient radiation to condense all of the exhaust during normal winter, using some live steam during extremely cold weather. The heating peak occurs in the morning when there are boilers in bank, so that fixed charges and boiler-room wages are not increased, the only extra expense being for coal, and a better return on the entire investment can be secured. B. J. DENMAN.

Yes, provided there is not too great a discrepancy between the available exhaust steam and the heating load.

The central-station company can afford to use some live steam Sundays, holidays, and extremely cold days, of which there are but few per season, generally speaking. When steam has to be used all through the heating season then too much heating surface is supplied, unless the rates charged for heating service are exceptionally high. In special and unusual cases live-steam heating can be made to pay, but usually not.

It would be good practice to keep the average heat demand inside the available exhaust. F. N. JEWETT.

When supplied from an electric light station, it is generally the case that there are only a few hours per day when there is sufficient exhaust steam to carry the heating load. However, all of the exhaust steam available can be used when supplemented with live steam, without increasing the back pressure on the engine. In fact, there is always a slight vacuum, excepting when the temperature of the circulating water approaches the boiling-point. Where the conditions would justify any kind of a central-station heating plant, a hot-water heating system would generally prove economical.

The principal objections to it are as follows:

(1) If there is a very great difference in level between the pumps and highest point to which water must be forced, there is a heavy pressure on all of the piping connected with the system, and the bursting of a fitting might result in flooding some customer's house or store with hot water.

(2) Most of the customers available have their premises piped for steam, and a change to hot water would be very expensive.

(3) The mains first installed should be of the ultimate capacity of the plant, since an increase of capacity can be obtained by more rapid circulation of water, which means higher pressure, and there is, of course, a limit to this.

H. T. Hartman.

In view of the fact that since heating by hot-water method of distribution can not be carried out through the meter system of charging, it would not be advisable to take on a heating load beyond the amount of exhaust steam that can be utilized for heating the water. American District Steam Co.

Yes, if by "entire" load you mean all the heating in zero weather. The best paying plants use part live steam for short periods during extreme weather. Fred. W. C. Bailey.

With a proper schedule of rates, based on the cost of the service, there can be no doubt that it will pay, if the system is reasonably well designed and operated without undue extravagance.

R. S. Wallace.
Ludwig Kemper.

Boone, Iowa, has such a commercial plant, and it is not a paying arrangement.

R. H. Hadfield.

It depends upon revenue per square foot of radiation or revenue per unit of connected load. Under ordinary conditions, with a rate of 15 cents per square foot of radiation and the ordinary exhaust load from the small central station, live steam for heating will not pay. GEO. N. TIDD.

J 2. In the use of direct-pressure district steam heating. (a) What rates are charged? (b) In what manner is the pressure regulated? (c) How should the pressure vary with the temperature? (Give records if possible.) (d) Is this method of district heating financially successful? (e) Give practical suggestions for successful operation and management.

(a) The rate should be based upon the cost of fuel to the individual user, and where there is a wide variation in the size of buildings and a considerable difference in the type of buildings heated, an accumulative sliding scale of rates should be adopted. The question is too broad to be answered briefly. The prices range from straight meter rate of 40, 50, 60 and 75 cents per 1000 pounds in various cities, and on accumulative basis from 35 cents to $1.00 per 1000 pounds of condensation, depending on the quantity used.

(b) The regulation of pressure is through a pressure-regulating valve of proper design placed in the direct-steam connection in the station, and operating in conjunction with a properly placed and designed back-pressure valve located in an outlet from the heating system.

(c) Pressures are regulated in modern plants designed for deliveries under initial pressures from two pounds to three pounds, according to the demand factor. In older plants and in some of the more recent ones some slight changes in initial pressure are made following the outside temperature, wind and humidity conditions. Illustrations of this feature were given in a paper and discussion on the subject of *Central Station Heating* at the twenty-fifth annual convention of this association.

(d) Decidedly so, where plants have been properly designed and are properly managed, and where the method of charging and rates are properly carried out. Local conditions, and so forth, must be taken into consideration in all cases. Ordinarily, it would not be policy to install a district steam-heating system connected to a universal exhaust main in the power-

(b) Pressure is regulated by pressure-regulating valve at the power-house.

(c)	Freezing point	3 pounds.
	25 degrees above	5 pounds.
	10 degrees above	6 pounds.
	Zero	7 pounds.

This experience for three years past.

(d) Yes, at the above rate.

(e) Successful operation and management means everything. It is absolutely necessary to have frequent inspection of traps and meters, and it is good practice to read condensation meters every 10 days.

Meter everything, including the condensation in mains and at manholes where the grade changes.

With 8000 feet of mains installed, our condensation does not exceed five per cent of all the steam delivered during the heating season of eight months. J. A. BENDURE.

The following rate seems to work out very satisfactorily:

First	10,000	pounds'	condensation	at	90c.	per	1,000
Next	10,000	"	"	"	80c.	"	1,000
"	10,000	"	"	"	70c.	"	1,000
"	10,000	"	"	"	60c.	"	1,000
Excess used in same month				"	50c.	"	1,000

Subject to a discount of five per cent if paid on or before the 10th day of the month following service.

(b) By a reducing valve, which can be set at any pressure desired.

(c) Depends entirely on local conditions—length of mains, class of buildings to be heated, character of inside piping and the radiation of consumer. One imperfect job might injure a whole system. Pressure varies from two and one-half to four pounds; not more than four pounds with the outside temperature at 14 degrees below zero.

(d) Yes.

(e) A large amount of radiation connected within a limited radius from central station, depending upon size of mains installed and amount of exhaust steam available for heating purposes. A

/stem for regulating the amount of condensation and sold entire- on a meter basis. L. R. CRAWFORD.

(a) 50 cents per 1000 pounds, plus $4.50 per month during e heating season; subject to 10 per cent discount for prompt ıyment at the office. The rates are too low for this locality.

(b) Through reducing valve, thus superheating the steam; :sides giving reserve for sudden demands.

(c) Doubt whether any satisfactory table could be worked ıt. Wind and humidity must also be considered. Further, the eam mains are not enlarged every time additional consumers 'e added and the drop in pressure would not remain constant ır the same atmospheric conditions. A table worked out for ıe year would probably be of little value for the next if much :w business were added.

The best way to take care of this is to have a recording steam ıuge placed in the mains at the point of lowest pressure. This ın be inspected two or three times each day and the boiler-room ›reman instructed, or put in an electric signal from the place to ıe boiler plant.

(e) First—Equip the boiler plant to evaporate 1000 pounds water at the least possible cost.

Second—The use of condensation meters.

Third—Buildings piped to operate with one-pound pressure coldest weather and so that no steam or water can escape with- ıt passing through the meters.

Fourth—An adequate rate and one that will properly take .re of all factors and particularly discriminate equitably, on basis cost of service to company, between consumers occupying a cer- in length of mains and using a small amount of steam per year ıd those occupying the same length and using a larger amount of eam.

The first three propositions are not hard, but we have as yet 'en no solution of the fourth. The square feet of radiation or ıbical contents of a building seem of no value for fixing maxi- ıum demand, since records show that the condensation per :ason will vary from less than 150 pounds per square foot › over 1500. A similar variation is found per cubic foot of space heated. Further, neither of these factors bear any relation to the length of mains occupied. W. J. GREENE.

(a) Rates by meter, using both steam and condensation meters, range from 25 cents to $3.00 per 1000 pounds of steam or condensation. Rates based on the amount of radiation connected, or the cubical contents of the building heated, range from 15 cents to 50 cents per square foot of radiation per season, and from $2.00 to $4.00 per 1000 cubic feet of space heated.

(b) The pressure is ordinarily regulated by means of a pressure regulator or reducing valve, in case steam is supplied from high-pressure steam boilers. The pressure regulator maintains a predetermined constant pressure in the mains, a considerable range of pressure being obtainable by the adjustment of weights and springs. In case exhaust steam is supplied, a back-pressure valve maintains the pressure within a predetermined maximum.

(c) The increase of pressure in cold weather should be only sufficient to compensate for the increase of friction drop due to the greater amount of steam flowing through the mains and should not exceed two pounds in a well designed system. The range of pressure necessary to compensate for temperature variation must necessarily be determined by experiment for every system of mains, and must be corrected as additional radiation is connected.

(d) Yes.

(e) See *Report of Committee on District Heating* to National Electric Light Association, 1905. R. S. WALLACE.

Rates charged in some cases are on a basis of previous coal consumption by customer during period of year under consideration.

(b) Reducing valve on live end and vacuum siphon on return end.

(c) The pressure is maintained the same, regardless of weather conditions. Increased cold increasing steam condensation and consequently amount supplied to live main.

(d) I understand that it is not successful.

R. H. HADFIELD.

J 3. Have central steam-heating plants proven a success in ities of over 100,000? Where?

Replying to this question, we will say that we have no peronal knowledge of any such plant that can be called an unqualied success. However, we are of the opinion that such a plant ould be made a success by an electric lighting or railway comany that generates its power by steam, by distributing exhaust team for heating within a radius of one-half or three-quarters f a mile from the plant, on a meter basis. This is on the suposition that the steam plant carries all electrical load or at least proportionate part of it throughout the day, and is not used nerely as a peak station. J. B. Lukes.

From experience and investigation, I have secured satisfacory evidence to demonstrate that steam-heating plants properly nstalled and properly managed are successful in large cities as vell as in small ones. Where one is found that is unsuccessful, he cause can usually be located and can generally be traced to oor equipment, poor management, or both.

The underground work of a steam-heating plant is the foundation of the business, and unless the very best materials are used ınd these materials properly installed, satisfactory operation and ommensurate results need not be expected; every detail of the ntire plant requiring the same attention to insure success.

The plant that the Northern Manufacturing Company is intalling in St. Paul, Minnesota, although in operation, is not comlete, but even in its incompleted state is giving splendid satisaction, and there is a growing demand for steam for heating urposes at a price that will insure a fair margin of profit to the ompany.

The underground work, which consists of about three miles f mains ranging in size from 6 to 20 inches in diameter, id partly in tunnels and partly in trenches, covers the congested usiness area of the city.

I think it is reasonable to say that in the very near future, e distribution of steam for heating purposes in large cities ill be found as desirable and necessary as such other commodies as gas, water and electricity. G. O. House.

317432

A properly-designed and properly-installed central heating plant should be a success in a city of 100,000 inhabitants or over. The growth of the business is necessarily slow, but it is our experience that, "Once a customer, always a customer."

Our plant was partially ready for operation late in the fall of 1903, and we ran through that winter with just five customers. In 1904, we obtained a very substantial business, and in 1905, the present winter, we have more than doubled all our previous business.

The amount of business that we have on our mains at present is rather less than half of the total available business. Our mains have been laid out with the idea of taking care of about 90 per cent of the heating to be done, so you will readily see that our standing charges are still very high; but we have reasonable expectations of obtaining practically all of this business within the next two years, and when we do this, we expect the plant to be a financial success.

There is no question whatever of the mechanical success of properly-installed steam plants. J. S. Lewis.

From our experience, we believe that a steam-heating system confined to the business section of the city is a very good adjunct to the business of a central station supplying electric light and power and using exhaust steam for its steam-heating business. While if all the items that should be charged to the cost of manufacturing the steam are so charged there may not be a very large profit in this particular department, it enables the company to secure the sale of current for electric light and power purposes to customers whom it would otherwise be unable to obtain, that is, customers who would put in a steam plant for heating purposes and then go a step farther and install in connection with the same an isolated plant for their electric light and power current. G. W. Brine.

I do not think that question can be answered broadly either in the negative or affirmative.

Before we decided to install a heating system in this city the writer went over the matter very carefully and in our particular case it seemed that it would be more than advantageous and paying, taking into consideration that it would be run in conjunction with the electric light and power business. The distance that steam can be carried economically, investments and losses being considered, in connection with denseness of the territory to be supplied, is necessarily limited, and in our case we purpose to take in only a territory of about 12 or 14 blocks north and south and about eight blocks east and west, our plant being located not in the centre of this territory, but a little in the northwest part. This territory takes in the heart of the shopping district, theatres, and a large number of the wholesale dry goods houses. From this section of the town we naturally get a large percentage of the best paying business from an electric light and power standpoint, as the district is entirely in the Edison direct-current district, and a territory in which we specially dislike to have isolated plants, for it is a well-known fact that a plant started in a block is very apt to grow into a block-lighting proposition, demoralizing rates and causing trouble all along the line for the central-station operators. There were a number of buildings in this territory that either had isolated plants, were arranging to put them in, or were threatening to do so, and with whom we could not deal satisfactorily so long as they had to generate their steam for heating purposes seven months in the year; but the moment that we were able to approach these people with a proposition to relieve them entirely from a plant of any kind in their building, we were able to do business with them to their and our profit. Our station is not completed, although we have steam on a portion of our mains (starting the plant the sixth of last December), but we have already shut down one of the largest plants in the town, have closed a contract for another large building, the lessees of which already had figures for their own plant, and have fixed a number of other buildings so that the thought of an isolated plant is entirely gone from them. In this way we feel that the heating plant will be very remunerative investment, although if it were run entirely independent, I think that we could pay a good percentage on our investment.

There is one feature of the question that I think needs considerable thought, to wit, that of the size of the town. To the writer it does not seem to be so much the size of the town (within reasonable limitations) as the physical and business character of the town. Any town that will permit a connected radiation load of from 200,000 to 300,000 square feet within a reasonable distance from the boiler plant, would seem to the writer to be a good town for heating, provided the character of the buildings was of a high order, and fuel was not too cheap. In our case, as stated, while we have a population of some 230,000, we are not attempting to cover anything but this busy business district.

I would conclude by stating that while we have only been operating about a month, and were unable to go after the early fall business, as we could not promise heat until late in the winter, we have not solicited very actively, owing to our unfinished condition. We already have some 60,000 square feet of radiation connected or to be connected to our station.

We sell all our heat on a meter basis, charging 65 cents for the first 50,000 pounds of condensation per month, 55 cents for the second 50,000 pounds of condensation per month, and 45 cents for all over, with a rebate of 10 per cent if paid on or before the tenth of the month.

Pardon the length of this reply to your letter, but I could not answer your question in a few words. R. E. RICHARDSON.

J 4. Can a district steam-heating system be made to pay when the average cost to the consumer is 30 cents per 1000 pounds of condensed water as measured by meter, the system not being provided with a return pipe to the plant? Cost of coal $1.85 per ton.

It is doubtful if an average evaporation of seven pounds of water per pound of coal is obtained; then for each ton burned there would be 7×2000 = 14,000 pounds of steam.

If all were sold at the rate named, the gross receipts would be 14×30 cents = $4.20 per ton of coal burned.

Coal costs $1.85, leaving for all operating expenses and fixed charges, $2.35. Compare this with electric current sold at five cents per kilowatt-hour.

If a station used 10 pounds of coal per kw-hour output, then for each ton of coal burned there would be sold 2000÷10 = 200 kw-hours output.

200 kilowatt-hours at five cents, $10. Cost of coal, $1.85, leaving for other operating expenses and fixed charges, $8.15, and central stations have now found this not too much of a margin for dividend paying. F. N. JEWETT.

This question is asked without enough naming conditions as to whether the steam-heating system could be made a success if steam were sold at an average price of 30 cents per 1000 pounds condensation, coal costing $1.85 per ton. In order to make good success under these conditions the volume of business would have to be unusually large and the evaporative efficiency of the coal fairly good, in order to overcome the factor of overhead burden, made up principally of interest on the investment, cost of management, insurance, taxes, lost accounts, and so forth, and the construction of the underground system of mains would have to be of the very best to reduce maintenance, depreciation and, particularly, transmission losses. Determination as to whether the plant would be sufficiently successful financially would have to be figured out by parties who were conversant with operating conditions, results and construction details covering most of the various plants in operation.

AMERICAN DISTRICT STEAM CO.

The average revenue of 30 cents per 1000 pounds of condensation, with steam coal costing $1.85 per ton, is too low a rate, and it should not be necessary to supply steam to consumers from central heating plant at less than an average of 40 cents per 1000 pounds. C. R. MAUNSELL.

No; impossible for any returns at 30 cents per 1000 pounds of condensed water with coal at $1.85 per ton, or even less.

J. A. BENDURE.

I know that a steam-heating plant at 30 cents per 1000 pounds with coal at $1.85 will be an absolute success, provided you have enough exhaust steam to do the heating. E. S. KELLY.

This question can not be answered without additional data. Probably 30 cents per 1000 pounds condensation would scarcely more than cover operating costs. R. S. WALLACE.

Thirty cents per 1000 pounds is a very low rate. Its being made to pay depends on fixed charges, and whether or not isolated plants can be shut down if steam is supplied for heating.

B. J. DENMAN.

Very difficult to make it pay at 30 cents per 1000 pounds of condensed water if there is not plenty of exhaust steam. Under absolute exhaust-steam conditions can be made to provide a fair return.

GEO. N. TIDD.

No. The coal cost alone to evaporate 1000 pounds of water would amount to approximately 20 cents. When you get below 50 cents per 1000 pounds of condensation, even under the most favorable circumstances, it is a losing proposition.

L. R. CRAWFORD.

Little chance to pay more than operating expenses. Repairs of steam mains, management, care of meters, etc., will average at least 7 cents per 1000 pounds of steam sold. The amount of water that can be evaporated per pound of coal is not given; but if taken at 7 actual, or 8.5 from and at 212 degrees, as being unusually good average results, including banking and starting fires; and 45 cents per ton, plus cost of coal, is taken as a fair average for the cost of operating boiler plant; and an average efficiency for the steam mains is taken at 70 per cent.

The station cost per 1000 pounds sold would be	$0.23
Cost of distribution and sale	0.07
Total cost	$0.30
For interest, depreciation and taxes	nothing

If the plant is operated in connection with an electric plant, the cost of steam chargeable to steam heat might be reduced 50 per cent, with very best relation between engine and heating load. This condition would leave, when basing electric plant on condensing operation and giving the heating plant the entire benefit of the combination, 11.5 cents per 1000 pounds sold, to cover interest, depreciation and taxes. The investment in steam mains and extra boiler capacity would be at least $1.80 per 1000 pounds sold. The earnings might, therefore, be about 7 per cent, an insufficient amount to cover interest, depreciation and taxes.

W. J. GREENE.

J 5. Can a direct-pressure, water-return, steam-heating plant be made to pay, using live steam exclusively, where the average cost of coal to the consumer is $7.50 per ton and to the plant $4.50 per ton?

A steam-heating plant can be made to pay if the price obtained for heating is sufficient. This depends entirely upon the size of the town, as in larger towns, on account of the convenience, rates may be obtained that would ordinarily be considered excessive. Under conditions named I should say that 40 cents per square foot of radiation per season would bring good returns.

A. W. ZAHM.

Yes, provided the entire heating business can be made available without undue investment, and further provided that the steam furnished be charged for on the basis of meter measurement. Live-steam heating may be considered purely as a manufacturing business and the greatest profit is derived when the steam is manufactured in sufficient quantities to effect the greatest possible economy in generating cost. Local conditions have so much to do with determining the probable earning value of any heating installation that a fixed rule which may be generally applicable can not be laid down. H. C. EDDY.

J 6. What is the most satisfactory method of charging for steam heating—per thousand feet of cubical contents, square feet of radiation, or water evaporated?

The only equitable method of charging for heating is upon the basis of the meter measurement of steam consumed by each customer. Flat rates have been generally abandoned by gas and electric companies and are now being rapidly superseded in the telephone field by measured-service rates. A difference in consumption of heat by individuals using heat under the same general conditions is very great. Two adjacent buildings of the same character and having the same class of occupancy rarely use the same amount of steam per square foot of radiation or per 1000 cubic feet of space heated. It is, therefore, unfair to both consumer and company to apply the same rate per 1000 cubic feet of space or per square foot of radiation.

Heat is a commodity that is perhaps more readily wasted than almost any other form of public-service supply. Waste of gas or electricity is always apparent to the consumer, because it is visible. The waste of heat is not ordinarily apparent to the consumer until a considerable time after the waste has begun.

The waste of gas and electricity is, or may be, instantly stopped by turning off the supply. The waste of heat being evidenced by a considerable increase in temperature, heroic measures are usually applied as a corrective, through opening of doors, windows, and so forth. This, in turn, further augments the condensation of the steam in the radiation, thus exposed to cold currents of air, and calls for an additional supply from the central station without producing additional revenue.

It has been the inevitable rule, where steam-heating companies have changed from a flat rate to a meter basis of charging, that their experience is similar to electric lighting companies making the same change; that the total gross revenue is but little, if any, reduced and is sometimes considerably increased with a reduction of the total amount of steam furnished and with a corresponding decrease in operating expenses. H. C. Eddy.

Flat rate per square foot of radiating surface per heating season is decidedly preferable in Alabama climate, because it eliminates complaints.

Birmingham Railway, Light & Power Co.

No doubt the fairest way of charging for radiation is by means of a condensation meter. By allowing the consumers to install whatever radiation they see fit, they will seldom, if ever, put in the required amount of radiation. A charge of $5.00 per 1000 feet of cubical contents would be an equitable charge, and in this case a consumer could install as much or as little radiation as he saw fit, yet the price would be the same in either case A. W. Zahm.

By steam meter Walter Flint.

J 8. Are there any steam meters in service for measuring the steam used by private consumer in varying quantities?

There are several steam meters on the market, but all of them are more or less complicated and costly. The St. John meter is an indicating meter which forms a record upon the chart, the area of which, when measured, gives the quantity of steam supplied. The Sargent meter is not a recording meter, but indicates, as an ammeter does, the amount of steam flowing through it at any given time in pounds per hour. The meters most generally used for such service are water meters, adapted to weigh and record the discharge from the trap of each individual consumer, thus measuring the quantity of steam that has been condensed in his radiation. H. C. EDDY.

There are two reliable steam meters, namely, the Sargent, for measuring live steam, and the condensation meter made by the American District Steam Heating Company. A. W. ZAHM.

J 8. Can Parsons steam turbines be successfully used in connection with a district steam-heating plant, the turbines exhausting into the heating mains? When so used, how do turbines compare with cross-compound Corliss engines for economy of steam consumption, and is there any liability of distortion of the rotor with consequent stripping of the blades?

Parsons steam turbines can be and are successfully used in connection with steam-heating plants. When so used these turbines ordinarily use about the same amount of steam per kilowatt-hour as reciprocating engines under the same conditions. The writer understands that the manufacturers of steam turbines make some slight modification in the design when they know beforehand that turbines are to operate under such conditions, the changes in design relating to the number of expansions of the steam while passing through the turbine. The writer does not clearly see how any possible distortion of the rotor could occur. The application of back pressure in this case would be equivalent, so far as its mechanical effect is concerned, to a reduction of the mean effective or average pressure applied to the rotor through its entire length. H. C. EDDY.

K—GENERATORS AND EXCITERS

K 1. Give briefly the advantages and disadvantages of direct-connected and belted units.

The advantages of direct-connected units are small floor space per kilowatt capacity, the absence of belts and their troubles.

The disadvantages lie in the inability to carry extra armature, the higher first cost, and the impossibility of changing from one type of generator to another should the necessity arise. In units of over 300-kilowatt capacity belts should not be considered. In the smaller-sized units the efficiency of the direct-driven and belted units are practically the same.

EDISON ILL'G CO. OF WEST CHESTER.

Among the advantages of direct-connected units over belted units are economy of floor space required, and higher efficiency, first by eliminating transmission losses in the belt; second, increased efficiency of generators because of necessity they will be slow-speed, which means smaller friction and iron losses, quieter and smoother running. Some of the disadvantages are higher first cost, and in small plants the direct-connected system will not be so flexible as the belted unit.

L. D. NORDSTRUM.

Some of the advantages of direct-connected units are as follows: Less floor space required. This is very important in cities where ground is expensive and where stations are already crowded with machinery. Absence of belts, which are always a source of danger both to life and apparatus, as well as a source of care and attention on the part of the attendants. The efficiency is higher due to absence of belt loss. Concentration of apparatus renders it easy for the operator to care for the prime mover and generator. A slow-speed generator is usually a more stable and better machine.

Some of the advantages of a belt-driven set: In the first place, it is cheaper. It is a more flexible installation in that the generator may be more easily moved in case of emergency and used elsewhere. The generator may be readily used as a motor necessity calls for same. Also, in case the plant is changed and e set thrown out, the belt-driven machine will probably be ore salable and more easily disposed of. It is also possibly sier to synchronize, in case of alternating-current generator, ving to belt slip. M. C. TURPIN.

(Practically concurrent opinions expressed by H. A. STRAUSS, AYTON F. GEIGER, ERNEST F. SMITH, A. PETERS.)

K 2. Has any installation of "umbrella" type generators en made for direct-connection to vertical water-wheels, and is e same considered good practice in this country?

The plant of the Niagara Power Company is an instance in oint, if I correctly understand the question. With the possible ception of the disputed question of frequency, the Niagara ant must certainly be regarded as good practice.

CHARLES W. COMSTOCK.
H. A. STRAUSS.

K 3. What is the cause of arcing between segments of the mmutator of an alternating-current generator?

Poor insulation will cause it, but the usual cause is copper ust and dirt. Keep commutator from cutting, and keep clean.

B. A. SCHAK.

Arcing is due to presence of dirt or particles of copper, hich form a path for the current. C. W. HIGGINS.

Arc if continuous is probably due to bad connections in compound winding. If only at brushes, may be due to improper djustment. There should be an even number of segments in e commutator and the brushes should be set on odd numbers part. W. H. GREENSLIT.

Loose contact or open circuit in compensator circuit, loose r badly-spread brush, rough or dirty commutator, incorrect osition of brush, or overloaded generator.

FRED. W. C. BAILEY.

Brushes on rectifier too far advanced. Sudden change of load will also cause arcing. A. PETERS.

Arcing between segments of the commutator of an alternating-current generator can be caused by particles of copper dust collecting in the insulation between the segments, and when a sufficient amount of the dust has collected at any point an arc will be formed across this point from one segment to the other. Also, the lack of good insulating material or a piece of this material working out will cause the current to jump and arc across from one segment to the other. Also, if the brushes of the commutator are not set correctly, so that they strike the right segments in passing under the brushes, excessive sparking will be caused.
H. W. DEV., WESTCHESTER LIGHTING CO.

Arcing between segments of the rectifier of an alternator is caused by variations in the power factor of the load. In order to obtain sparkless operation it is necessary to shift the direct-current brushes to positions corresponding with the various power factors. ERNEST F. SMITH.

Poor insulation between segments, too much oil or dirt on commutator, brushes not properly set, or too much or not enough brush surface. F. W. BULLOCK.

K 4. Two belt-driven compound-wound generators—one 75-kilowatt and the other 100-kilowatt capacity—are arranged to be run in multiple. By itself the 75-kilowatt machine is slightly overcompounded, but the two run perfectly together. What would be the result if these machines were thrown together without the equalizer-switch being closed?

What the result would be if the machines were thrown in parallel without closing the equalizer switch depends largely upon the difference in regulation. If the 75-kilowatt machine is compounded much over the 100-kilowatt machine, it will take all the load; and a sudden change of load might reverse the polarity of the 100-kilowatt machine.

tried the experiment on two small generators. One is pole, drum-wound, and the other two-pole, ring-wound. The ture reaction of the ring-wound is much greater than that of rum-wound. I found that when the no-load voltage of the wound machine was about 115 and the no-load voltage of rum-wound machine about 105, they could be thrown in lel. Under these conditions, with no load, the drum-wound ine ammeter showed a negative current. Then, as the load thrown on, both ammeters read positive. When the load ncreased further, the ring-wound generator took more than are, until finally it carried almost the entire load. A quick val of the load resulted in reversing the polarity of the wound machine. A. M. Wilson.

If the voltage has been properly adjusted, the generators be thrown together without closing the equalizer switch. e load is then adjusted in proportion to the machines they run satisfactorily. C. W. Higgins.

Undoubtedly, the 75-kilowatt machine would take practically the load. F. C. S., Malden Electric Co.

One would motor; which would depend upon the condi- under which the switch was closed. P. M. Lincoln.

One of the machines will be injured by reverse current.
C. K. N., N. Y. Ed. Co.

It would seem as if 75-kw generator would tend to take the er portion of the load and would probably run the 100-kw rator as a motor. M. C. Turpin.

The smaller machine, on account of its overcompounding, d endeavor to run larger machine as motor until its abnormal would reduce its field, then the reverse condition would take if the circuit breaker on the smaller machine did not trip to nt it. With the equalizer closed there should be no trouble chine characteristics are the same. F. D. Sampson.

One machine would probably take all of the load and drive the other one as a motor. Unless characteristics of both machines are practically the same, can not be operated to advantage in parallel without equalizer. GEO. N. TIDD.

If the voltage were equalized and the machines were connected in parallel, with the equalizer switch open, the 100-kw under-compounded generator would become motorized; its speed would become excessive and the progressive increase in strength of reverse current through series winding would reverse the polarity of the generator and build up its shunt field in reverse direction. The machines would then both generate in series in the same direction, causing heavy current to circulate through the local short circuit formed by main direct-current 'buses, switches, generator leads, and so forth. The generators would slow down under the heavy load thus thrown upon them and would burn out unless the circuit-breakers or other protective devices properly performed their functions. ERNEST F. SMITH.

One machine would probably take the whole of the load and tend to drive the other machine as a motor, reversing the current flowing through the series winding. This would instantly result in a shut-down through the blowing of fuses and might cause damage to the machines. DUGALD C. JACKSON.

K 5. In case of emergency, could a 550-volt, compound-wound generator be run at 250 volts on the same 'bus with shunt-wound, 125-volt machines running on three-wire system?

A 550-volt compound-wound machine could not be operated in this way at normal speed, owing to its great instability at half voltage. It would be necessary to run it at approximately half speed to get the magnetic density high enough to make the machine stable. Then, the fields of the 550-volt machine should be divided in halves and the two halves put in multiple, taking their excitation from the 250-volt 'buses. In this way the machine would operate very well if the field current was not heavy enough to overheat the rheostats, since this current would be about twice normal, due to the fields being in multiple. If the machine gave trouble from its compounding, the series field could easily be short-circuited. The kilowatt capacity of the machine is of course about half the name-plate rating when run this way.

H. D. LARRABEE.

Yes, by reconnecting armature so as to put two coils in parallel and increasing thickness of brushes so as to cover twice as many segments of commutator; also put fields in parallel and change field resistance to twice the ampere capacity. I have operated a General Electric 300-kilowatt four-pole, belted, 550-volt generator in this manner in parallel with one 250-volt and two 125-volt generators for a year or more. W. T. OVIATT.

Have used 550-volt compound-wound generator to supply power for an Edison three-wire, 125-250-volt system, by placing jumper across the series coils and running it as a plain shunt nachine. Would advise any one attempting to rely on a reserve f this character to make test run in order to be fully acquainted ith conditions when an emergency should demand the use of the achine. EDISON ILL'G CO. OF WEST CHESTER.

It can be and has been done in certain cases where the 500-lt generator was equipped with sufficient rheostat control to able the machine to be controlled at the lower voltage. The tput, however, is much reduced at the lower voltage.

L. L. ELDEN.

The emergency combination suggested in this question is tirely possible, though before the 550-volt compound-wound nerator is thrown in parallel across the two 125-volt machines, e compounding should be completely short-circuited or removed some other manner. WM. B. JACKSON.

A 550-volt generator would have to be excited from 250-volt us-bars, the fields be put in multiple and speed adjusted to one-alf. A. PETERS.

Yes; but it would be necessary to lower speed of machine, which in turn would decrease its kilowatt output greatly.

W. H. Greenslit.

Yes, but with very poor economy.

C. K. N., N. Y. Ed. Co.

Have tried as a booster an Edison three-wire system, with poor success. B. A. Schak.

No. A. M. Wilson.

Yes, if series winding is disconnected. F. R. Spiller.

In case of emergency almost anything has to be done in order to assure continuity of service. Under these conditions a 550-volt compound-wound generator might be run on the same 'bus with a 250-volt generator, but it would not be satisfactory, on account of its being run at such a low point on the saturation curve. This would mean that any slight change in the field strength of the generator would produce a much greater change in voltage. It would probably be better to cut out the series winding and run the machine shunt-wound. It would also probably be necessary to furnish a new field rheostat, as the one designed for 550-volt generator would probably not give good regulation with the generator running at 250 volts. M. C. Turpin.

By cutting out the compounding, putting fields in parallel to secure full field strength, machine can be operated at 250 volts in parallel with shunt-wound 125-volt machines without difficulty. Capacity of the 550-volt machine reduced one-half.

Geo. N. Tidd.

Not with satisfactory results. However, if the series winding of the 550-volt machine were effectively short-circuited or cut out and a rheostat of ample range connected in the shunt-field circuit, the machines could then be operated under light load at 250 volts, in multiple with other machines on the three-wire system. Sparking at the brushes would be excessive, owing to severe armature reaction. In case the prime mover driving the 550-volt generator would regulate satisfactorily at half speed (which is not probable), the operation of the 500-volt machine at half voltage in multiple with other machines would be entirely satisfactory under all loads within its rated capacity, as the field strength could then be retained at normal and the armature reaction would not be excessive. ERNEST F. SMITH.

K 6. What should be the ratio of capacity of the exciter to the alternator?

It depends upon conditions. For large-capacity, low-frequency, high-speed alternators, such as turbos, one-half per cent of the capacity of alternators is ample for excitation. For high-frequency, low-speed and relatively small-capacity engine-type alternators, the exciting energy may be as high as two or three per cent of the capacity. P. M. LINCOLN.

The relation of exciter capacity to generator capacity depends upon the characteristics of generator and the power factor of its load. FRED. W. C. BAILEY.

The exciters should be from one and one-half to three per cent of the capacity of the alternator. C. W. HIGGINS.

The capacity of the exciter is governed by the excitation energy required by the alternator. It is usually about three per cent of that of the main generator. The exciter should be selected of a size to care for the excitation of the generator under *normal full-load operating conditions.* The increased field current required by the main alternator, due to operation with inductive loads, should be considered in the phrase "full-load operating conditions." A good general rule would be to call for an exciter capable of handling the excitation required for the main generator at normal full load when operating on a load having a power factor of 80 per cent.

Occasional or periodic abnormal operating conditions of the main generator will be taken care of by the usual overload capacity of the exciter, which should be designed to have the usual overload capacity of direct-current machinery.

H. A. STRAUSS.

The size of exciter required depends in every case upon the characteristics of the alternator to be excited. In a 1000-kilowatt, 60-cycle unit, operated at 100 revolutions, the exciting current exceeded three per cent at unity power factor, full load. In a 2000-kilowatt machine of somewhat closer regulations, the excitation amounted to less than 2.5 per cent while in steam turbines, owing to their high speed, the excitation is less than one per cent of the total output of the alternator.

THE PHILADELPHIA ELECTRIC CO.

K 7. Are rotary converters being operated successfully inverted?

A 300-kilowatt rotary in the power-house of the Elmira Water, Light and Railroad Company, has been operated successfully as follows: First, taking alternating current and delivering direct current; second, taking direct current and delivering alternating current; third, operated as a belt-driven unit and generating both alternating and direct current. H. M. BEUGLER.

The local street railway, which also operates a 25-mile interurban railway, receives power from power-house 14 miles out. The generating plant is all 550 volts, which is put through two inverted rotaries, stepped up to 13,000 volts, sent to each end of the line, stepped down again and through another rotary, finally being delivered to trolleys at 550 volts. The power-house also feeds the trolley direct current. This arrangement works very satisfactorily, but can't say much about efficiency.

W. H. FELLOWS.

Inverted rotaries are operated in a number of plants. They are used by the Union Railroad Company, Providence, R. I.

C. W. HIGGINS.

Rotary converters are run inverted on interurban railway circuits with complete success. Take the following conditions:

In the power plant all the generated power is direct current, 500-volt, the power fluctuations being deadened by a storage battery. The alternating current for a suburban line about 20 miles long is obtained by running a converter inverted and stepping-up the voltage to about 15,000 volts. If the substation converter is excited so that the inductive effect of the line is overcome under all running conditions, there can not be much chance of the inverted converter running away. For lighting loads, it would be necessary to regulate the system so as to prevent too great lag on the alternating-current side of the inverted converter. A. M. WILSON.

Yes. FRED. W. C. BAILEY.

We have operated a 60-cycle, 300-kilowatt, 3-phase rotary converter inverted; taking direct current at one substation from the street railway plant and transmitting alternating current in parallel with generators to two other substations. The direct-current side of all rotaries and the railway plant were connected and the alternating-current sides of all rotaries were kept connected with our plant. The compound winding was cut out on the inverted rotary and the field current decreased sufficiently to motor the direct-current side. This method of operation was used to reduce peak load on our plant during December and worked very satisfactorily. W. J. GREENE.

Yes, in a great number of cases. The writer has in mind one 200-kw, 60-cycle, 250-volt direct-current rotary that runs twenty-four hours per day. Half the time it runs as a rotary and the other half as an inverted rotary, and gives excellent satisfaction.
M. C. TURPIN.

Yes, the speed is very sensitive to variations in power factor of the load, and the position of the direct-current. Brushes require careful attention in order to avoid excessive firing. No converter should be operated inverted unless provided with a reliable speed-limit device capable of promptly opening the circuit in case of system trouble causing heavy lagging currents to be drawn from the inverted converter.
ERNEST F. SMITH.

K 8. Why should a three-phase system, supplying rotaries and synchronous motors only, be other than in perfect balance, and how much does it vary in actual practice?

A three-phase system supplying rotaries and synchronous motors operating at a reasonable high power factor should practically be in perfect balance, if all of the apparatus is as it should be.

In case the rotaries and synchronous motors should be run with an extremely low power factor there might be considerable unbalancing, owing to the magnifying of the very slight variations in the magnetic and electric circuits of the generators and motors. WM. B. JACKSON.

K 9. If two or more inverted rotaries are running in parallel on the alternating-current side, is there a constant shifting of load on account of phase difference?

Yes; but it is usually small in amount. H. D. LARRABEE.

K 10. What is the best method of controlling automatically the frequency of inverted rotaries?

Have an exciter that will give necessary voltage when the field is worked at a low density. As the rotary increases in speed, the exciter voltage will build rapidly, thereby strengthening the field of the rotary and holding the speed down. If speed lowers, the exciter voltage will lower, thereby weakening field of the rotary and speeding it to proper point.

F. R. SPILLER.

K 11. What has been the experience of those who have used in practical work a system of automatic synchronizing of rotary converters?

K 12. What has been the experience of large companies operating numerous large rotary converters as to the comparative merits of staggering every other set of carbon brushes on direct-current side with reference to one another, or of staggering by groups of adjacent positive and negative brushes with reference

to one another? The latter method of staggering being used for the purpose of avoiding the uneven wear on the commutator, due to electrolytic deposition of copper on the face of the positive carbon brushes from the copper commutator immediately under the brush face.

Prefer the latter method of staggering. F. R. SPILLER.

K 13. Has experience ever shown that the end-play device on a rotary transformer is beneficial to the wear on the commutator?

The end-play device is exceedingly beneficial to the wear of the commutator. It is impossible to keep a good commutator surface without a certain amount of end play.

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Yes; and for the wear on the bearings also.

H. D. LARRABEE.
F. R. SPILLER.

While it is our practice to use end-play devices, we ran three 1000-kilowatt rotaries for about five months without them. The commutators would not take a polish, but became covered with small ridges, as did the rings also. After putting on the end-play devices, the ridges soon disappeared and the commutators have now a nice polish. THE BROOKLYN EDISON, T. N. HICKS.

Yes. I have had good results from the operation of this device. RALPH R. LAXTON.

K 14. Has general trouble been experienced with pig-tail brushes on rotary converters under abnormal overloads or at times of serious high-tension system disturbances?

Yes. H. D. LARRABEE.

We had considerable trouble with one style of pig-tail brush, but generally speaking we have had good results. The pig-tail of this brush was inserted in a hole in the top, the rest of the hole being filled with solder to hold the pig-tail. On heavy loads the solder would melt, allowing the pig-tail to drop out.

THE BROOKLYN EDISON, T. N. HICKS.

K 15. What is the usual average power factor of a motor-generator system? State conditions.

The average power factor of large systems supplying synchronous motor-generators and rotary converters is in practice 98 and 99 per cent. The average power factor for a somewhat smaller system supplying exclusively induction motor-generator sets would be about 75 or 80 per cent. P. JUNKERSFELD.

An induction motor-generator set will frequently have a power factor as low as 80 per cent at full load. A synchronous motor-generator set may have a power factor of unity.

H. A. STRAUSS.

The average power factor of motor-generator system, transforming from the high-tension central-station current to the low-tension Edison mains, is about 80 per cent.

THE PHILADELPHIA ELECTRIC CO.

K 16. In cases where the regular operating procedure of shutting down a rotary-converter unit equipped with an induction regulator provides for opening the fields of the converter before it comes to rest, has trouble been frequently experienced in subsequently starting the converter from the direct-current end, due to the residual magnetic condition of the static transformer?

K 17. Outline best method of starting up large systems of, say, 20,000-kw capacity, in stations and substations with batteries after shut-down of all generators and converters.

Start generators and then rotaries, taking the load from the batteries as the generators and rotaries are cut in.

F. R. SPILLER.

K 18. What has been observed to be the limiting feature in connection with a rotary-converter equipment employing induction regulators, concerning maximum capacity of same?

K 19. Do turbines make a 60-cycle rotary system preferable to a motor-generator system?

The prime mover has nothing to do with the relative advantage of a 60-cycle rotary or a motor-generator set. The difficulty involved in 60-cycle rotaries lies mainly in mechanical construction of the rotary itself, due to the relatively large number of poles required. H. A. STRAUSS.

No. Do not like rotaries. F. R. SPILLER.

K 20. Where a very large fluctuating power load is being run from the same motor-generator sets as the lighting load, what means should be employed to keep the pressure steady?

A voltage regulator on the generators. A Tirrill regulator will handle any variation within reason. F. R. SPILLER.

(Practically concurrent opinions expressed by M. C. TURPIN and P. JUNKERSFELD.)

K 21. Is it practical to take two single-phase alternators, couple the shafts together and use them as a two-phase machine?

Yes. This was the method adopted by one of the large manufacturing companies with the machines it exhibited at the World's Fair, Chicago, 1893. It would, however, hardly pay.
H. A. STRAUSS.

Yes, provided means are taken to arrange the armatures so that the e.m.f. are in quadrature. In fact, it was in this manner that polyphase currents were first generated. M. C. TURPIN.

Provided the machines are the same, are excited from the same 'bus to ensure polarity being the same, and the one advanced ahead of the other the requisite amount. A. PETERS.

It can be done, but would, however, be at best poor economy; trouble with one alternator would put out of business all two-phase apparatus connected to system. F. D. SAMPSON.

It is practical to make up a two-phase alternator by rigidly coupling two single-phase alternators together so that the phases of the generator electromotive forces come in quadrature relation; but the arrangement is cumbersome, and undesirable for that reason. DUGALD C. JACKSON.

K 22. Is it economy to buy a three-phase alternator and use it for single-phase lighting?

Yes; well-designed three-phase alternators will give 80 per cent full-load rating on single-phase lighting. Power can then be taken from alternator at some future time when growth of business demands, provided, however, 60-cycle apparatus is contemplated. F. D. SAMPSON.

Yes, for several reasons. The three-phase machine should be cheaper for the same output; you will save copper in your distribution and transmission system; you will be enabled to run alternating-current motors from your line. H. A. STRAUSS.

Should think it would depend on local conditions and prospective power business. Three-phase machine should give about three-fourths of its output when running single-phase.
M. C. TURPIN.

A three-phase machine operating as single-phase will give 68 to 70 per cent of total three-phase capacity. I should think that unless there are special reasons for purchasing three-phase, single-phase machines would be the better. A. PETERS.

No; unless it is probable that a power load can be built up later or unless a revolving-field machine is desired.
H. D. LARRABEE.

This question is pretty completely answered under M 1.
WM. B. JACKSON.

K 23. Can a 2200-volt, 125-cycle alternator be changed in peed and connected to generate 2200 volts at 60 cycles?

It is entirely possible and practicable to use a 2200-volt, 125-ycle alternator as a 2200-volt, 60-cycle machine by a proper eduction in speed, if it is possible to change the armature con- ections from a parallel connection to a series connection.

This has recently been done by the writer with good practical uccess. WM. B. JACKSON.

By running at the properly-reduced speed, 60-cycle current ould be obtained, but the heating due to excess field current ecessary to obtain 2200 volts would probably burn out the field pools, not to speak of the extra heating of the armature due o increased core loss at this decreased frequency.

M. C. TURPIN.

Reduce the speed to that requisite to give you sixty cycles. ewind armature with a shade over twice the number of turns er coil there are in present coils, the wire being half the area present winding. You will then have a 60-cycle, 2200-volt ma- ine of half the former capacity. A. PETERS.

No. Voltage is the product of number of turns of wire, field rength and frequency. Hence, with the same machine, dividing e frequency by two means doubling the field strength to give e same voltage, which is practically impossible.

H. D. LARRABEE.

No; not unless it is rewound. CHAS. W. STONE.

K 24. What advantages have compound over shunt-wound nerators for substation work?

If you are doing lighting from the substations, compound-ound machines are essential to prevent too great variations in oltage for changes of load. If power only is being furnished om the substations, shunt-wound machines will prove satisfac- ry, but compound-wound machines have the advantage first ted. H. A. STRAUSS.

Compound-wound generators are of great advantage, for both railway and power work, in maintaining the proper potential on the system when the load fluctuates considerably. Shunt-wound generators are preferable for lighting, as the changes in load are not rapid, and they are simpler to manage in case of short-circuits and so forth. Chas. W. Stone.

Maintenance of e. m. f., with rapidly varying loads.
A. Peters.

K 25. Are there any plants in the northwestern part of the country generating at 10,000 volts or more? If so, are all details of operation satisfactory, and are generators particularly liable to injury by lightning when used without step-up transformers?

There are a number of stations generating at 10,000 volts and a considerable number going in at 13,000 volts. Operation is quite satisfactory and there are no generator troubles due to lightning. The essential point in such installations is to put in a first-class system of conductors between generator and switchboard and switchboard and line. H. A. Strauss.

K 26. I have seen a three-phase induction feeder potential regulator (2300-volt) which showed as great a loss (heat) in itself at no boost as at 120 volts boost. Is it a special feature of the regulator, belonging to this class, to have a rather low all-day efficiency?

Regulator is probably arranged so that the primary side is connected to the line all the time, consequently full potential is placed across the regulator and the heating due to the magnetizing current results. M. C. Turpin.

The core losses in such a regulator are practically constant, and the C^2R losses vary with the load, so that there must have been some other trouble than that stated in the question.
Chas. W. Stone.

Low power factor load. Probably most of single-phase motors connected to one phase. You might divide the single-phase motors equally between the two phases, but it will be practically impossible to entirely eliminate the trouble and keep the present combination of apparatus in service. If you can add a synchronous motor, or substitute one for a part of the inductive load, it will help materially. RALPH R. LAXTON.

K 27. How can we improve our power factor, which to-day has a minimum of 60 to 65 per cent and a maximum of 80 to 85 per cent, according to the load and the time of day? Our generating units consist of one 400-kw and one 600-kw, three-phase, 60-cycle, 2300-volt G. E. generators. Our day load averages 500 kilowatts, 90 per cent of which is three-phase power. Our street lighting, which is from the tub system and amounts to 155 kilowatts, has a power factor of 60 to 65 per cent. Our commercial incandescent and arc lighting, which has a peak load of from 200 to 300 kilowatts, has a power factor of about 90 per cent. Under the very best present operating conditions an 80 per cent power factor is about as high as we obtain. A loss of 20 to 25 per cent in generating capacity of central station is a serious condition.

In case there are any power installations wherein synchronous motors can be installed, it is both possible and practicable to improve the conditions stated. In case it is found necessary to take care of a great amount of lagging current, it might be found desirable to install synchronous motors of considerably larger capacity than the power required of them, so that the reserve capacity could be used in taking care of lagging current.

WM. B. JACKSON.

It may be possible to install synchronous motors in some of the places where induction motors are now used, which would help a great deal. If such a condition exists, I should imagine that going over the system carefully and eliminating as many transformers as possible, and grouping transformers of larger capacity would also improve matters. CHAS. W. STONE.

It might be well to look over customer's motors and see if they are well loaded. An induction motor running light or lightly loaded has a very poor power factor. Consequently, with a number of motors in this condition on the circuit the power factor of same would undoubtedly be very low. If it is found that power factor could not be improved in this manner, the conditions would probably justify putting in a synchronous motor. By adjusting the field current of this motor, power factor of the system could be raised to very nearly unity. M. C. TURPIN.

Put a synchronous motor on your line and adjust your power factor by regulating the field of the motor.
H. A. STRAUSS.

Put in a 175-kw single-phase generator for the tub system.
H. D. LARRABEE.

Why not by a synchronous motor running idle, connected to 'bus-bars? A. PETERS.

K 28. A 500-kw, two-phase, 66-cycle, 2500-volt Stanley inductor-type generator, which when running under full load of incandescent lighting will carry equal voltage on each phase at terminal board, with a power factor of 90, when running on one-half load, consisting mostly of Westinghouse two-phase and Wagner single-phase motors, will drop its voltage very much lower on one phase than the other and will give a power factor of only 65. What is the trouble and what its remedy?

We have an approach to this same trouble. The phases at the light load are most likely unbalanced, probably due to the single-phase motors, and, if so, the armature reaction distorts the field and causes the difference in voltage. If the amperes on the two phases differ or, the amperes being the same, the power factors differ, this distortion will occur and the voltage be unbalanced. The remedy is to keep the phases absolutely balanced both as to amperes and power factor. W. H. THOMSON, JR.

Is it not probable that single-phase motors are not properly distributed between the two-phase lines? See answer to K 27.
M. C. TURPIN.

good babbitt metal for high-speed

L—STORAGE BATTERIES AND BOOSTERS

L 1. Would a storage battery in an alternating plant be a paying proposition to take care of part of peak load and furnish light power by day?

No; for direct-current apparatus would have to be provided to charge the batteries, and distributing system would perhaps not permit of the use of the batteries on the line. If it would it would necessitate two distinct distributing systems. A synchronous motor-generator set might be used to alternately charge the batteries and deliver alternating current to the distributing system, but do not deem it advisable. L. D. NORDSTRUM.

There is no reason why a storage battery in an alternating-current plant should not be just as good a commercial proposition for handling the peak load and carrying the total load throughout the lighter portions of the day, as such battery installations have proven in connection with direct-current lighting systems. A rotary or motor-generator set would, of course, have to be operated with the battery. J. LESTER WOODRIDGE.

If the load were light only, a battery could be used; but if it consisted of light and power it would necessitate installing converting apparatus. In general, it is not practicable to use a storage battery for the day load. Its best purpose is for peak service or emergency reserve. LOUIS I. PORTER.

No. Profitable use of storage batteries in connection with an alternating-current plant is for purposes of insurance of service and not for general use as suggested. L. L. ELDEN.

Not generally; specific cases may show advantages.
H. A. STRAUSS.

(Practically concurrent opinions expressed by A. O. FRETZ, A. M. WILSON, E. L., CHICAGO EDISON CO.)

L 2. In plants where the exciters are not driven by separate prime movers, is it becoming general practice to install storage

batteries and keep same "floating" on the exciter 'bus wires? Are the results satisfactory?

In a high-class installation the installation of storage battery for insurance of the excitation is imperative. The results are very satisfactory if proper care is given the battery.

L. L. ELDEN.

(Practically concurrent opinions expressed by E. L., CHICAGO EDISON CO., CLAYTON F. GEIGER.)

Storage batteries floating on exciter 'bus-bars would be a necessity in the case of exciters being driven by motors, in case of a general shut-down. A. PETERS.

It is becoming general practice to install storage batteries for floating on the exciter 'bus, not only in cases where the exciters are motor-operated, but also where the exciters are driven by separate prime movers. Where the exciters are driven by alternating-current motors, the battery floating on the 'bus prevents a change in speed of the alternator from producing a magnified effect on the voltage due to the change of frequency and of the speed of the exciter set. In any event, the storage battery affords an insurance of continuous service at a cost that is insignificant as compared with the results accomplished. The results of such exciter-battery installations have been entirely satisfactory. J. LESTER WOODRIDGE.

The use of the storage battery in connection with exciter system of any station depends upon the degree of reliability necessary. In most large central stations a battery is kept floating on the exciter system at all times; there are, however, a few exceptions to this rule, where all the exciters are independent steam-driven units. THE PHILADELPHIA ELECTRIC CO.

Considerable advantage may be derived from a storage battery floating on the exciter 'bus, when more than one alternating-current machine is in use. A secondary advantage consists in the possibility of using the battery for illuminating the plant in case of a complete interruption of service. C. C. GARTLAND.

No; this is very unusual. Would avoid this arrangement if possible. H. A. STRAUSS.

L 3. Why do not storage-battery manufacturers rate their products for efficiency and capacity in kilowatt-hours instead of ampere-hours? Is it because near end of charge the e. m. f. of generator has to be raised considerably and this would bring the efficiency in kilowatts low, the increased e. m. f. falling as soon as charge is discontinued?

Some manufacturers rate their batteries on a kilowatt-hour basis. The capacity of a battery expressed in terms of kilowatt-hours means more than if stated in terms of ampere-hours. The ampere-hour capacity of an entire battery is that of a single cell, irrespective of the voltage, while the kilowatt-hour capacity of a battery is dependent upon the ampere-hour capacity and the average voltage on discharge. Usually it is sufficient to state the capacity in terms of ampere-hours at a particular rate of discharge. E. L., CHICAGO EDISON CO.

Ampere-hour rating has no significance unless the voltage is specified. It is the *energy* input that governs here as well as with any other apparatus. H. A. STRAUSS.

When charging storage batteries the current as a rule is kept constant, the e.m.f. varying. As cells become charged the e.m.f. rises abruptly and falls as rapidly on stopping charge. This, while it would count if batteries were rated in kilowatts, does not if they are rated in amperes. The efficiency therefore will show up higher under the latter (ampere) rating.

A. PETERS.

L 4. What is the usual efficiency of a storage battery in kilowatt-hours, i. e., percentage of efficiency between, say, a month's input in kilowatt-hours and month's output in same? The battery being well cared for and having maximum charge once a week, other charges being kept three points low.

A comparison of a number of months' use of nine batteries having a total capacity of 6650 kilowatts at the one-hour rate of discharge gives results varying in the different months from 58 to 61 per cent, considering the batteries collectively. Individual batteries considered separately varied from 47 per cent to 67 per cent. L. L. ELDEN.

A twelve months' average gave efficiency of 57 per cent in kilowatt-hours. A. PETERS.

The kilowatt-hour efficiency of a central-station storage battery, well cared for and operated under usual service conditions, is about 75 per cent. HUGH LESLEY.

This question as stated can not be satisfactorily answered. Efficiency depends upon the amount discharged and the care exercised in charging. E. L., CHICAGO EDISON CO.

The usual efficiency of a storage battery in kilowatt-hours is about 60 per cent. LOUIS I. PORTER.

L 5. What are the objections, if any, to discharging batteries at high rates in case of emergency?

None; provided discharge is not carried too far and does not exceed the maximum allowable discharge of battery.
A. PETERS.

In strictly emergency cases, which are presumably of rare occurrence, it is permissible to run the discharge rate up to any amount necessary, provided the point is not reached where there is danger of melting plate lugs or connections; four times the hour rate is safe in this respect. HUGH LESLEY.

Very heavy discharges are liable to disintegrate the positive plates. This is occasioned by the fact that so much gas is liberated at such times that frequently the paste is driven off with it. Moderately heavy discharges for short periods, however, should have no ill effects. S. R. INCH.

L 6. If, in case of an emergency, a storage battery is carrying the entire load of a substation and the interruption continues beyond the capacity of the battery, when should the battery be disconnected?

When the e.m.f. per cell gets down to 1.8 volts, unless you an recharge very soon after, in which case it can go to 1.7 volts.

A. PETERS.

The battery may be kept in circuit until its voltage drops to ne point where the pressure on the distributing system is so ow that useful illumination from the lamps is no longer obtained, rovided the battery can be immediately recharged when the enerator service is restored.

HUGH LESLEY.

L 7. What are the comparative advantages of the high-voltge rotary and the booster set for charging the battery in a otary battery substation?

The advantages of high-voltage rotary are as follows:

First—Reduced first cost of installation. The saving due to mitting the booster will, however, be partially, and perhaps rgely, offset by the extra cost of the rotary and apparatus for ontrolling its voltage.

Second—Improved efficiency.

Third—Reduced floor space.

Fourth—Greater simplicity in operation on account of educed amount of machinery to manipulate.

The above advantages, especially first and second, are based n the assumption that a rotary may be used which must in any vent be installed, and which is of about the proper ampereapacity for charging the battery. If a special rotary must be rovided, the above advantages disappear. The disadvantages of ne high-voltage rotary as compared with the booster set, are as ollows:

First—It will either be necessary to run one or more rotaries o carry the outside load, in addition to the high-voltage rotary or charging the battery, or if one rotary of sufficient capacity upplies both the charging current and the outside load, then the otal current supplied by this rotary, including that which charges he main battery and that which goes to the outside load, must ass through the cells. This latter may involve either charging he end cells at too high a rate or reducing the charging rate of he main battery to a very small amount. In fact, even if the main battery is not charging at all, the current passing through the end cells to the outside load may charge cells at an excessive rate.

Second—If one rotary is to supply the charging current and also the outside load, a greater number of end cells will be required than if the battery can be disconnected from the 'bus and charged by means of a booster.

Third—If it is desired to charge the end cells separately from the main battery, two rotaries must necessarily be run, and the charging rate of the end cells can not exceed the outside load at the time without reversing the current in the rotary that is connected to the main 'bus. J. LESTER WOODRIDGE.

L 8. Is an exciter battery necessary to insure the protection of central-station service against exciter-current interruptions?

In every large and moderate-sized alternating-current station an exciter storage battery is particularly desirable and in the best modern stations is considered a necessity.

P. JUNKERSFELD.

Yes, if exciters are driven by induction motors.

A. PETERS.

No; but in some cases it may be of some service. It is better to keep the exciter system as simple as possible, and have duplicate units which can be started quickly when necessary.

CHAS. W. STONE.

The storage battery is the only source of electrical energy that is not subject to sudden breakdown in service. The deterioration of a battery even under extreme abuse is gradual. For emergency service, therefore, the storage battery is the only type of electrical apparatus that can be absolutely relied upon, and an exciter battery is therefore necessary if absolute protection against interruptions in the exciter current is desired.

J. LESTER WOODRIDGE.

L 9. What is the average life of positive plates in terms of equivalent complete discharges?

L 10. What experience have you had with, and what is the advantage of, the tray plate style of storage batteries?

L 11. Give method of keeping end cells, which are only used occasionally, in good, healthy condition.

Only charge about once each week. A. PETERS.

End cells, which are used but occasionally, can be kept in good condition by giving them a complete charge at weekly intervals. A complete charge implies the continuance of the charging until both maximum specific gravity and voltage are reached and the cells are gassing freely. HUGH LESLEY.

L 12. What is the best battery-room floor construction?

A good hard tile laid on concrete. A. PETERS.

Vitrified brick pointed with pitch. CARROLL HODGE.

L 13. What kind of paint is most serviceable for use on battery-room iron and copper work?

Asphaltum. A. PETERS.

A special grade of heavy black asphalt paint.
CARROLL HODGE.

M—SWITCHBOARDS, INSTRUMENTS AND STATION WIRING

M 1. Can one phase of a three-phase system be used for single-phase lighting and other phases for power, by putting voltage regulator on lighting phase only?

This can be done, but it is far better to balance the lighting load between the three phases, even at an additional line cost. Our system was laid out for single-phase lighting from a three-phase machine and when the load begins to approach capacity the machine is badly out of balance, making the three ammeters show up something like 60-60-35. Of course the regulation of one phase is simple enough, but the trouble is that the machine can not be used up to its full capacity without badly overloading on two legs. If we do not overload two phases we can get only about 75 per cent of the kilowatt capacity of our machines. H. D. LARRABEE.

The one phase of a three-phase system can be very satisfactorily, and frequently is, used for single-phase lighting, while the three phases are used for power. It is not uncommon to use one phase for lighting and the other two phases to carry the arc-lighting service while the three phases are used for power. With careful combination of the load it is frequently unnecessary to have a regulator even upon the lighting phase; the regulation being done with reference to this phase through the generator field. WM. B. JACKSON.

This would be governed somewhat according to the percentage of the power load. The writer does not think that it would be policy under average conditions. This is, of course, assuming that the three-phase system runs out of the station and the intention is to put a feeder regulator in one leg and put all the lighting on this leg. F. C. S., MALDEN ELECTRIC CO.

It is common practice to use one phase of a three-phase system for single-phase lighting, regulating that phase for the lighting service and allowing the other phases to run at the regular bus pressure. Where more than one circuit is operated from the station it is advisable to arrange the various circuits so that the lighting phase of each circuit comes on different phases of the system, so that it may remain at all times approximately balanced. L. L. ELDEN.

Can see no reason why this arrangement could not be successfully used, unless there were great fluctuation in the power load, in which case it would be preferable to use separate machines and circuits. F. TOBEY, JR.

You may use three-phase machine, as desired, by inserting series transformer in main leads of machine and connecting the secondaries of transformer to compounding of generator. There should be some means of caring for the amount of compounding current, which is preferably done by a number of taps being brought out from the secondaries of series transformer. By adjusting the compounding of each phase to suit the load, the voltage regulator may be connected to the potential transformer of the lighting phase and made to operate on the exciter field, thereby carrying the desired voltage on the entire machine. An over-compounded machine will give the best results for such uses.

W. H. GREENSLIT.

It can, if you wish to use your machines at about one-third their full capacity. If your load is such that you can not do this, balance your circuits or transformers on two phases as nearly as you can, or better yet, arrange circuits and switchboard so operator can balance by switching to suit the occasion. Would recommend single-phase for small plants, because satisfactory single-phase motors are on the market equal in efficiency to any multiphase motor. Would, barring single-phase, prefer two-phase apparatus to three-phase; simpler, easier to balance load between two phases than three.

F. M. VANDER VOORT.

Lighting circuits can be taken from one phase of a three-phase machine and a regulator placed on this phase, while polyphase power could be taken from all three phases of the generator and not from the other two phases, as the question indicates, unless single-phase power is meant. The best way, however, would be to place a Tirrill regulator on the machine, keeping its voltage constant irrespective of the load or power factor, placing compounding coil of the regulator (by means of series transformer) on the lighting circuit above mentioned. This would insure the voltage being automatically compounded according to the load on the single-phase lighting circuit.

M. C. TURPIN.

Yes; in a four-wire three-phase system. The regulator may be installed either in the phase wire or in the neutral; preferably the latter, if the lighting load is to be confined to one phase only.

ERNEST F. SMITH.

Yes; but not advisable. Use the three phases for lighting as well as power and balance up the lighting load.

GEO. N. TIDD.

Yes; if you have well-regulating engine and generator, install a hand-operated induction regulator on single-phase lighting circuit.

F. D. SAMPSON.

One phase of a three-phase system can be used for single-phase lighting and three-phase motors operated by the same system. In this case the voltage would be regulated only for the phase carrying the lighting load.

E. H. MATHER

Yes; if speed or engine regulation is good, the service will be fairly good.

W. W. FULLER.

Yes, if regulator is quick acting.

A. PETERS.

This should be feasible.

THE COLORADO SPRINGS ELECTRIC CO.
B. J. DENMAN.

M 2. What is the most satisfactory method of regulating the voltage of separate feeders operating from one generator?

The use of single-phase or three-phase regulators, either manually operated or automatically operated, of standard makes, has proved to be the only satisfactory method of regulating separate feeders from a three-phase system.

L. L. ELDEN.

For ordinary service, induction regulators to "buck" or "boost" about 10 per cent.

FRED. W. C. BAILEY.

Where it is possible, a return pressure wire from the centre of distribution of any circuit, in connection with a regulator of the Stillwell or similar type, will give the closest regulation. If it is not desired to put in pressure wires, very good results can be obtained with the above-mentioned regulator and a compensating voltmeter. The voltmeter and its compensator will require constant care, however, to keep them in calibration.

DOUGLAS P. MORRISON.

Assuming an alternating-current system is contemplated, the separate feeders may be satisfactorily and independently regulated by the use of a potential regulator connected in each lighting circuit. The regulator may be equipped with motor drive, relays and line drop compensators to provide for satisfactory automatic ndependent regulation of the circuits.

To provide against excessive variations in alternating-current bus voltage due to heavy power load fluctuations, a type of auto-natic regulator controlling the exciter 'bus voltage has been eveloped and put in commercial service with satisfactory results.

ERNEST F. SMITH.

In regulating voltage on separate feeders running from one enerator we use the pressure-wire system and separate-regulator stem. We find no choice in either system so far as regulation oes.

J. J. GAFFNEY.

Otherwise it would be necessary to place the booster regu-tor in each feeder circuit. See answer to M-1.

M. C. TURPIN.

It is understood that this refers to alternating current. Nearly l makers of transformers are prepared to furnish boosters for is purpose, which consists of suitable transformer with a number leads arranged in connection with a switch to cut in or out a rtain percentage of coil.

J. R. COX.

(Practically concurrent opinions expressed by W. T. OVIATT, J. DENMAN, A. PETERS, W. W. FULLER, COLORADO SPRINGS LEC. CO., GEO. N. TIDD.)

M 3. Is it desirable to take three-phase current from 'bus-ars and change it to single-phase current without balancing hree-phase system? How can it be done?

We run three-phase current to 'bus-bars, running three-hase mains from 'bus-bars for power circuits. For lighting cir-uit we run single-phase mains, and if we have five or six single-hase circuits, we divide them up on the three legs of the 'bus-bars, so that we get practically an even balance. This is somewhat more desirable than unbalancing, as unbalancing varies the voltage somewhat on the different legs. We have found this to work very satisfactorily for a number of years. In some plants we have a rotary switch, so that the single-phase circuits can be transferred to any leg to maintain an even balance when the condition of unbalancing in different seasons of the year quite noticeable; otherwise, the single-phase circuits are permanently connected to each leg with a switch and are not changed unless in time it is found necessary to change over to some other leg to balance up more properly.

F. C. S., MALDEN ELECTRIC CO.

Single-phase can not be taken from polyphase system without unbalancing the polyphase system. The only way to balance a single-phase load is to divide it equally among the phases of the polyphase system. P. M. LINCOLN.

Run three-phase feeders with single-phase mains or run single-phase feeders for various districts and equip at switchboard with compensated voltmeters and induction regulators. In any event, balance as close as possible. FRED. W. C. BAILEY.

This is physically impossible. The questioner is referred to an article by Chas. F. Scott, in the *Electric Journal*, Volume III, No. 1, for detailed treatment of the question. S. R. INCH.

It is not necessary to change from two-phase to single-phase. Simply take off one-phase from the bus-bars. It is not absolutely essential to balance the load accurately. Considerable unbalancing may be indulged in without causing trouble.

H. A. STRAUSS

There is no transformation necessary to obtain single-phase current from a three-phase system, it only being necessary to tap any two of the three-phase lines. If this is done, of course it will necessarily unbalance the three-phase system, but this can not be very well avoided, except by loading the other two phases. Any-well-designed three-phase machine should give about three-fourths of its output single-phase. M. C. TURPIN.

No. Some means of balancing load is necessary to work machine at full load. W. H. GREENSLIT.

Use one phase if you can not balance. A. PETERS.

M 4. What kind of insulated wire is considered best to-day for station wiring at 2300 volts?

Wire or cable having suitable insulation for the pressure at which it is to be used, and in turn covered by a substantial flame-proof or slow-burning braid, is the only proper wire to use for station wiring. L. L. ELDEN.

Any high-grade rubber insulation. Insulation should contain at least 30 per cent pure Para. Allow no reclaimed rubber, and call for insulation thickness as defined by National Electric Code for this voltage. Use lead covering only where you fear deterioration from moisture or detrimental fumes. In most power stations it is safe to do without lead covering. H. A. STRAUSS.

Use triple-conductor lead cable for three-phase station work and twin-conductor lead cable for single-phase work.
F. D. SAMPSON.

Rubber insulation with fire and weatherproof braids.
A. T. BEAUREGARD.

Rubber-covered wire. A. PETERS.

Lead-covered varnished-cambric cable in ducts.
FRED. W. C. BAILEY.

We are using in our different plants ordinary white, slow-burning so-called "Underwriter's Wire," depending entirely on good insulators for the proper insulation of same.
F. C. S., MALDEN ELECTRIC CO.

Rubber insulation, with an asbestos covering to prevent same from burning. **WARREN PARTRIDGE.**

Rubber-covered, 3500-volt, having an additional covering of non-combustible material. **W. H. GREENSLIT.**

M 5. How often should switchboard instruments, volt-meters, ammeters, indicating and recording wattmeters, be tested?

Voltmeters should be checked against a standard every day, as serious results would follow the introduction of error in such.

Indicating ammeters and wattmeters will keep closely enough to calibration not to require re-calibration oftener than once in six months.

Recording wattmeters should be checked every two months or three months at the least. **DOUGLAS P. MORRISON.**

The interval at which switchboard meters and instruments should be tested, varies with the type of the instrument, the condition under which they operate, and the accuracy required of them. For an average case, would suggest the following: Switchboard ammeters that are used in the regulation of lighting systems should be tested once a month; recording wattmeters of the direct-current type, tested once in three months, with inspection and perhaps test of potential drop over armature once each month; recording wattmeters of the induction type to be tested and inspected every three months; indicating wattmeters and ammeters, *et cetera*, which are used to indicate the approximate load on machines, feeders, *et cetera*, where extreme accuracy is not important, to be tested every six months.

In addition to the above, any unaccountable variation in the performance of the meters should be noted and investigated.

TOLEDO RAILWAYS AND LT. CO.

At least once every six months, except where you are selling or buying energy by instrument readings at power-house. Then test at least once a month. **H. A. STRAUSS.**

Machine instruments should be tested regularly at intervals of about three months. Feeder meters should be tested every six or eight months. ERNEST F. SMITH.

Voltmeters should be checked monthly, and other instruments at intervals of from three to six months, according to amount of daily use. C. W. HIGGINS.

From eight to twelve months; voltmeters from four to six months. FRED. W. C. BAILEY.

Twice a year should be sufficient to keep instruments of good makes in a condition for accurate indications and registration.
L. L. ELDEN.

We make a regular practice of testing thoroughly twice a year. If faults are noted we test oftener.
F. C. S., MALDEN ELECTRIC CO.

At least twice a year. H. E. RYDER.

We test our switchboard instruments, including recording wattmeters, once a year; this does not indicate that the instruments do not receive constant attention. W. W. FULLER.

At least once each year.
THE COLORADO SPRINGS ELEC. CO.

It is good practice to keep a voltmeter and ammeter on hand as standards, by means of which all other instruments can be, from time to time, compared. If the standards are used but little, the necessary re-calibrations would be seldom. J. R. COX.

M 6. How much of a heavily-fluctuating railway load does a recording wattmeter actually register?

Have watched instruments many times and the wattmeters appear to follow closely the changes in load. I think that 90 per cent to 95 per cent of the current is recorded.
C. W. HIGGINS.

A wattmeter operating on a fluctuating load, like a railwa circuit, will record the true output within commercial limits fo the reason that, disregarding friction, which is small, the los from failure to respond instantly to an increase of load will b made up by the similar gain when the load is falling.

From a practical standpoint, therefore, the meter will recor the true output, although theoretically its record would be slightl less than the actual. DOUGLAS P. MORRISON.

There is no reason why this meter should not register all o the energy; the fluctuation would merely vary the speed of th rotating element. Notwithstanding this, the instrument should record all energy in circuit. F. D. SAMPSON.

M 7. What is the best method of testing large-capacity recording wattmeters on direct-current railway switchboards?

As voltage required on current coils is very low, use one or two storage batteries with resistance for a "load." For potential, take the steadiest proper voltage you can get. For standard reading, use Weston indicating wattmeter or Weston voltmeter and ammeter. If testing voltage varies too much, have one observer for instruments and one for meter being tested. Take one-minute readings. F. O. BROILI.

A steady load should be used to get satisfactory results. This may be obtained artificially by water rheostat, or storage batter if one is available. Where an extra meter is available, a ver satisfactory method is to standardize this extra meter on stead current, after which it can be inserted in circuit with any meter to be calibrated, and its registration compared directly on the regular railway load. C. E. BROWN.

M 8. What is the best method of determining, at the power-house, the total kilowatt-hours, generating at 11,000 volts?

Put in a recording or integrating wattmeter. They are guaranteed with a certain percentage of error no greater than for lower-voltage instruments of this class. F. D. SAMPSON.

Use integrating wattmeters on each of the generators.
CHAS. W. STONE.

M 9. Are automatic voltage regulators a paying investment and what make have you found to be the most satisfactory?

Yes. Tirrill, manufactured by General Electric Company.
F. R. SPILLER.

We have for some months past been using Tirrill regulator to control 'bus-bar voltage while operating lighting, power and railway load from the same 'bus-bars, and have secured very satisfactory results. With fluctuation in railway load of several hundred amperes, no appreciable drop in voltage is noticed.
T. H. T. & L. Co.

We have installed a General Electric Company Tirrill regulator. It is absolutely satisfactory, our voltage being constant so far as the eye can detect at the lights even though we have a very varying load. We have had the regulator three years. Its maintenance amounts to extremely little, either in trouble or money.
W. H. THOMSON, JR.

Have used Tirrill regulators, which regulate generator voltage. As to whether they are a paying investment, this is a matter to be decided in each individual case. Certainly is a paying proposition with us in satisfied customers, and leaving power-house attendants free to look after other things, as a Tirrill regulator can regulate better and closer than any human being. F. O. BROILI.

Good voltage regulators like the Tirrill regulator are an admirable investment where voltage regulation is needed.
DUGALD C. JACKSON.

Have found the Chapman improved an excellent instrument, and its results showed it a very profitable investment.
A. PETERS.

Automatic regulators are one of the best helps to a central station in many ways, and should pay for themselves many times over.
CHAS. W. STONE.

We are using two T.D. 125-volt regulators on our Edison three-wire system, with water power and find they give us a great deal better regulation then we could get without them.

F. A. Johnson.

M 10. On a three-phase distribution system of about 1500 kilowatts, what form of regulator is most satisfactory to keep the potential of the three 'bus-bars properly balanced?

No automatic regulator should be used to keep the 'bus-bars balanced, as unbalancing is caused by the load. Automatic regulators should be used on the feeders to control their potential.

Chas. W. Stone.

M 11. After the line-drop compensators are once set for alternating-current circuits, should they be re-adjusted, and how often?

We find it advisable to re-adjust the compensator on our alternating-current circuits about three times a year.

United Elec. Lt. Co.

Line-drop compensators when once set, if properly designed, should need no resetting unless some radical change is made in the line.

Chas. W. Stone.

The setting of line-drop compensators for alternating-current work will vary as the electrical centre of gravity of the feeder changes. A general test for pressure should be made at least every two or three months and re-adjustments made on the compensator to satisfy the conditions found.

The Brooklyn Edison, T. N. Hicks.

M 12. Give opinion of the merits of ordinary separate-well, switchboard type, oil switches for use on high-tension transmission lines on rotaries.

M 13. What causes a G. E. 500-ampere, 4000-volt, type H motor-operated switch, supplying a 100-mile, 60,000-volt transmission line through a bank of step-up transformers, to open and close of itself?

This is a very peculiar phenomenon. Should like to know some of the details. When and under what conditions does this switch open, and does the motor itself appear to operate the switch? M. C. TURPIN.

The cause of such complaint is improper adjustment of the mechanism. The "H" oil switches that have opened and closed themselves, are known as form "H-2." This switch differs from the present "H-3" in that the "H-2" switch has no positive latch which the "H-3" has. E. M. HEWLETT.

M 14. On which side of large direct-current generators, running in multiple, is it common practice to place the circuit-breaker, and what are the chief reasons?

On negative side, because the series coils and equalizer are usually on positive side, and under certain conditions current might traverse the armatures inside of the breakers. A. PETERS

It is preferable to place the circuit-breaker in the circuit of direct-current compound-wound generators in the conductor leading from the side of the generator opposite from the pole where the equalizer conductor enters, provided a double-pole circuit-breaker is not used. A circuit-breaker placed in the conductor leading from the generator on the same side as the equalizer connection does not control the current flow through the armature. DUGALD C. JACKSON.

M 15. Describe any successful commercial installation of mercury arc rectifiers used as lightning arresters.

M 16. How often should bellows-type relays be calibrated, and what percentage of accuracy is it possible to maintain under ordinary conditions of operation?

One installation, thirty bellows-type relays, all set at 10 amperes, six seconds, were tested one year after installation. Six months after previous test all operated within the accuracy of setting (about 10 per cent) for current; one-half operated within the accuracy of setting (about 20 per cent) for time; 80 per cent operated within 30 per cent of time setting. F. F. KINNEY.

Bellows relays need not be recalibrated so long as the service conditions remain the same. They should, however, be inspected, cleaned, and operated by hand at frequent intervals, and to keep the leather pliable it should be oiled occasionally with neatsfoot oil. E. M. HEWLETT.

Roughly, at least once a week, as they change, due to atmospheric and other conditions not well understood.
A. E. WALDEN.

M 17. What is the best form of name-plate for switchboard work?

The best form of name-plate is probably a metal plate with a good-sized number or letter for each generator and feeder circuit. In addition to this a card holder for each feeder circuit is a help. In the holder is placed a removable printed card describing the circuit. If card holders are not used an index should be mounted near the switchboard describing the circuits under their respective numbers or letters. E. M. HEWLETT.

N—BELTS AND SHAFTING

N 1. What is the advantage of transmitting power by rope?

If you use the English drive system one broken rope will not interrupt your service; with the American drive it will simply mean splicing. Rope drive will conform better to the theoretical arc of contact between sheaves, and will also stand outdoor drive better than other forms of belting. Some cotton mill experts claim greater repair expenses for rope on account of difficulty in finding good rope splicers. F. D. SAMPSON.

N 2. What is the best thing to use to stop belt slipping?

If your belt is clean and free from oil, and still slips, it is undoubtedly overloaded. Get a wider belt, or increase the speed of the one you now have if it is running less than 4500 feet per minute. L. W. GREENE.

The best thing to keep belt from slipping is to use belt of sufficient width to carry the load easily without heavy tension. This is the most economical from a standpoint of power consumed, also cost of maintenance of belt and machinery.
F. A. JOHNSON.

If belt slips when under proper tension it is a sign you need a thicker or a wider belt. Workmen are inclined to overdo the application of belt dressing of any kind. Have used Cling-Surface with good results, also Dixon's; but both should be used sparingly.
WALTER FLINT.

N 3. What experience have you had with Cling-Surface on narrow and wide belts? Is it better than no dressing?

Cling-Surface has given admirable satisfaction on belts that have been running for a number of years under severe operating conditions, the widths of the belts being from 6 inches to 14 inches. The Cling-Surface has certainly improved the service obtained from these belts. DUGALD C. JACKSON.

O—OIL AND WASTE

O 1. What difference in the grade of cylinder oil is advised where 125° superheat is used in one case and saturated steam in another?

The oil for superheated steam should be of high flash test and in some cases should be compounded with fixed oil. On the other hand, there are cases in which it has been shown that the fixed oil is a disadvantage in using superheated steam. The oil for wet steam may have considerably lower flash test and should be made along lines that will allow it to spread rapidly on the valves and have such a viscosity that the moist steam will not wash it from the valve or its seat. FLORUS R. BAXTER.

O 2. What is the average price of a good cylinder oil to be used with saturated steam and flat gridiron valves?

An oil costing 55 cents per gallon gives good results with gridiron valves. Steam pressure 140 pounds. B. J. DENMAN.

In middle states, 50 cents per gallon for first-class article.
A. PETERS.

Good cylinder oil can be secured for 28 to 30 cents per gallon.
GEO. N. TIDD.

***O 3. What are the specifications for a suitable cylinder oil for water-cooled gas engines?**

A few years ago an oil of too high flash test could not be furnished to the manufacturers of gas engines, but very many of the oils on the market at present have a flash test not better than 380 degrees Fahrenheit, and these oils of low flash point deposit less carbon in the combustion chambers than did the heavier oils of a few years ago. Most of the gas-engine oils on the market to-day are pure mineral, though large quantities of compounded gas-engine oils are sold for use on stationary water-cooled gas engines, generating as high as 250 horse-power.

These points are given to show that the question of writing the specifications for gas-engine oil that will give just the oil that is needed for lubrication, to the exclusion of all others, is just as difficult as it is to write the specifications for a good steam-cylinder oil. An oil of from 380 to 400 degrees Fahrenheit, having a viscosity not far from that of neatsfoot oil of steam heat, but to be pure mineral and well refined, would lubricate 9 out of every 10 and possibly a larger percentage of water-cooled engines from 5 to 2000 horse-power.

The question of lubrication is not dependent on the color, though a filtered oil would show any floating impurities quicker than black oil. FLORUS R. BAXTER.

Flash point, 505.
Viscosity, 500.
Cold, 10.
Gravity, 28.
Temperature, 70.
Fire point, 560.

H. M. Beugler.

A good grade of engine oil (not valve oil) is found an excellent lubricant for gas-engine cylinders. C. C. Gartland.

O 4. Is there any oil made that will work economically in a "crankcase"?

I consider the crankcase method of oiling (especially the modern type of Ideal engine) the most economical in use. It makes no difference what kind of oil is used so long as it is not a vegetable oil. There are several crankcase oils on the market.

Geo. W. Richardson.

O 5. What is the cost per kilowatt-hour for cylinder oil? (State capacity and characteristics of station.)

The writer has under his supervision a small 60-kw electric light plant. The output is 50 kilowatts. One pint of cylinder oil runs this plant ten hours. The engine is 100-hp, high speed.

W. W. Fuller.

A station with 2000 indicated horse-power in four units generating about 90,000 kilowatt-hours per month required
100 gallons engine oil per month.
50 gallons cylinder oil per month.
50 gallons crankcase oil per month.

The combined cost of oil per kilowatt-hour was six-hundredths of one cent. H. A. Strauss.

Yearly average of 26 generating stations varying from 80-kilowatt capacity, high speed, non-condensing, to 18,000-kilowatt capacity, slow-speed Corliss engines, condensing, for two successive years .025 cent per kilowatt-hour. Individual stations ran from .085 cent to .012 cent for oil and waste.

DUDLEY FARRAND.

In large central stations using reciprocating engines the cost per kilowatt-hour for cylinder oil varies from 12 to 24 cents per 1000 kilowatt-hours. THE PHILADELPHIA ELECTRIC CO.

Two-hundredths cent per kilowatt-hour for cylinder oil; 1500-kilowatt capacity, 12 hours per day, load factor 75 per cent.

F. D. SAMPSON.

O 6. What is the cost per kilowatt-hour of machine oil? (State capacity and characteristics of station.)

See answer to O 5.

DUDLEY FARRAND.
H. A. STRAUSS.

Cost for machine oil at same plant referred to under O 5 would be approximately five cents per 1000 kilowatt-hour.

THE PHILADELPHIA ELECTRIC CO.

One-hundredth cent per kilowatt-hour for engine oil. Cross-compound engine, 1500-kilowatt capacity, 12 hours per day, load factor 75 per cent. F. D. SAMPSON.

O 7. What is the cost per kilowatt of waste? (State capacity and characteristics of station.)

See answer to O 5. DUDLEY FARRAND.

The same station (see O 5) showed a cost per kilowatt-hour for waste of $0.00003. H. A. STRAUSS.

Cost for waste, three-thousandth cent per kilowatt-hour. Cross-compound engine, 1500-kilowatt capacity, 12 hours per day, load factor 75 per cent. F. D. SAMPSON.

O 8. How does the cost of using waste compare with the cost of using wipers in the larger power-houses?

Have found the silk wipers made by the American Silk Company more economical than waste, but can not give exact figures.

EDISON ILL'G CO. OF WEST CHESTER.

I think engineers and managers will agree with me that unless issued by an attendant in charge of storeroom a bale of waste is so flexible that it will go around in five-pound quantities for a month no matter if the plant is 200 or 2500-horse-power.

GEO. W. RICHARDSON.

Best grade of waste, washed daily in steam waste-washer is cheaper. G. P. BULLIS.

O 9. Running a 225-horse-power high-speed engine at about half load, is it possible to use so small a quantity of cylinder oil as to increase friction in cylinder and valve chests to such an extent that it will noticeably increase fuel consumption and still not cause cutting? Briefly, if too little cylinder oil is used will it show first in cutting or in increased friction?

On a 250-horse-power engine the amount of friction required to cause cutting would be but a small fraction of the total power, and would not be noticed by the average engineer in the increased fuel consumption. The cutting will develop in most cases without the engineer knowing it, unless it be a very serious case.

EDISON ILL'G CO. OF WEST CHESTER.

It is probable that in starting up a new 225-horse-power engine, working under half load, that cutting and increase in friction due to a decreased feed of lubricating oil, would show themselves at about the same time. An engine that has been in service, working with a high grade of cylinder oil for a sufficient time to give a good oil polish to both the cylinder and piston, could probably be worked at half load with a diminished supply of oil for a few hours at a time without indications of increased friction or cutting of the cylinder. In the case cited, unless the pipe carrying the oil were extended to nearly the middle of the steam pipe, the engine working at half load would not be lubricated with the full amount of oil used while the engine was running at full load. This point has been directly proven in a number of cases. FLORUS R. BAXTER.

By using too-little cylinder oil, friction might be increased to an extent that would visibly increase coal consumption, but would be more likely to result in cutting as well. F. TOBEY, JR.

They coincide—friction *is* cutting; in actual operation cutting will become evident long before any difference in steam consumption becomes noticeable. Increase in steam consumption due to this cause could probably be detected only by very elaborate test.
H. A. STRAUSS.

Less than the required amount of cylinder oil will make itself evident first by increased friction, which if continued will show cutting. R. H. HADFIELD.

O 10. How much a gallon is it advisable to pay for cylinder oil for large Corliss engines?

Forty-five to fifty cents a gallon. F. D. SAMPSON.

In the middle states fifty cents will purchase an oil of excellent quality. A. PETERS.

O 11. Do you know of any place where the efficiency of lubricating oils can be tested? To save the "hocus pocus" in the oil business a test bureau is necessary.

The testing of lubricating oils is performed by the mechanical department of the college of engineering at the University of Wisconsin. DUGALD C. JACKSON.

P—OVERHEAD LINES

P 1. What methods have been devised, at once accurate and simple, for keeping records of city pole lines and the extensions thereto?

The writer has a map of the city, drawn to the scale of 300 feet to the inch, mounted on a suitable wooden frame and back, into which stout pins are driven corresponding with the location of the poles on the line. Small card-board tags about one inch square, such as are used by merchants in tagging goods, are used to indicate the transformers. They are tied to the pin corresponding to the location on the line. On one side of the tag is the description and capacity, and on the other side the names of the services being fed from transformer. The same method is used to indicate the lightning arresters, and the size of the copper.

The result is a very graphic and comprehensive representation at a very small cost. In connection with this, the adoption of a standard pole and cross-arm adds to its simplicity.

J. R. Cox.

In one of the plants with which the writer is connected, we have had made a complete survey by surveyors of all the poles in four cities that the plant covers and a sectional map made with the poles owned by the company, and jointly owned with other companies, and poles jointly occupied with others but not owned by us; the different poles being shown by different symbols, such as round, square, triangular, and so forth.

At the time of surveying, every pole was given a number. This number was stamped on the pole with a steel stamp so as to cut into the pole and make a permanent record. This number was put on the map and a card index made of every pole, also designating the poles carrying lights. The maps also show poles that have arc or incandescent lights. The extensions on this map are handled as follows: If there are any poles to be set, a preliminary plan is made by our superintendent of line construction showing the location. This is sent to a draftsman and put in proper form to be submitted to the city authorities. There are no numbers assigned to these poles until this plan of location is approved by the city. The approved plan is forwarded to the chief draftsman, who keeps the pole records. He then assigns numbers to the poles and sends plan to the superintendent of line construction and the poles are then set and numbered in accordance with this plan. After same is completed the plan is returned to chief draftsman and the extensions are added to the sectional plans. A blue-print made from this plan is sent to the city so that the chief draftsman and the office will have check on the plan until same is completed. For poles removed or replaced, a regular order form is used, which is in duplicate and is sent to the chief draftsman to make proper corrections in the sectional plans. Each city is furnished with a set of prints from these sectional plans and the intentions are to have a new set made once a year. Local office is supplied with a set of prints.

F. C. S., Malden Electric Co.

A system of pole records used by this company for approximately 50,000 poles, consists of a card for each pole in use, and a general map of the territory covered, upon which is placed an accurate tracing of each circuit. All poles are designated by numbers and a complete record of all attachments is shown by each card. Reports are made of all changes made on the pole lines and the proper changes are made daily on the pole cards after the work is inspected, two men being sufficient to care for these changes.

L. L. Elden.

District maps of fairly large scale, supplemented by card-index data covering details.

Fred. W. C. Bailey.

A loose-leaf scheme of maps on tracing cloth. All maps of standard scale, with circuits indicated, primary one color and secondary another color. This scheme allows changes in circuits with little extra work, as only a small section need be copied if circuit is changed on that section. Pole-position of wires, size of wires, location and number of transformers, can also be shown conveniently. Direct-current circuits can also be kept the same way.

The Colorado Springs Elec. Co.

Number every pole, locate same on pole maps and keep a (numerical) record of pole locations in pole book or on pole cards. Keep written records of every circuit from the station to the end of the line. Series circuits should be traced as a single wire from station to station: multiple circuits should be traced from station to end of line and each branch or sub-branch traced individually. A. T. BEAUREGARD.

A loose leaf, upon which is printed fac-simile of city block, showing intersecting streets, is quite satisfactory, distance between poles being given, curb line, and so on. Height of pole is represented by single circle for standard-height pole, say thirty feet, and tangential lines, one for each five feet in excess, running out from small circle. This record can be transferred to map made in large sections. F. D. SAMPSON.

The best and simplest method of keeping records of city pole-lines and extensions thereto would be to procure or trace a map of the city (scale 100 feet to the inch), and enter thereon the exact number, size and location of each pole erected in any part of the city on any permanent or specific working-order issued, the working-order number and date of completion to be entered on the map, with key on fly-leaf denoting ownership of different poles.

This in itself is quite sufficient so far as the question of poles is concerned. However, a card-system on work orders in connection with above would show correspondence relative to permits and arrangements with other companies, and would be of great value. A. R. KENT.

P 2. In keeping line records, are the results obtained by making a record of the exact location of each wire on every individual pole, either by pole cards, diagrams or otherwise, commensurate with the difficulty and expense of making these records and keeping them accurately up to date?

Yes, because the average central-station superintendent knows about as little of the location of wires on cross-arms as does his stenographer, and the record is handy when your "Bill," "John," or other oldest employee, leaves suddenly, thinking he is taking it all with him. I had such an experience in the matter of underground distribution where no field book or record was kept, my predecessor having taken with him what records were not kept in his head and the superintendent's knowledge being decidedly *nil.* The expense of "prospecting" would have paid for a dozen records. F. M. Vander Voort.

It would not be possible to furnish the information required of our company by the state unless the exact condition of each pole at all times was on record. We consider that the results obtained are worth the expense incurred in keeping the records in detailed form. L. L. Elden.

I do not think that it is on alternating secondary work, where the transformer is subject to change on account of increased or decreased load, sometimes removing the present secondary wires or replacing with wire of larger size.

This could be taken care of on a transformer-installation card system. As to the location of different circuits on the cross-arms I think it very necessary to have the circuit number or letter designated immediately under the pin on each cross-arm for the benefit of new men who are not familiar with the original installation.

A. R. Kent.

We consider that the advantage of an accurate record of pole positions is well worth the expense of keeping up such records.

The Colorado Springs Elec. Co.

Not for small plants. District maps showing diagram and sizes of wire under glass, with sticker-tags showing transformers, load centres, *et cætera,* are ample for small or medium plants. Use separate map for street-lighting circuits.

Fred. W. C. Bailey.

No. It is very difficult for the average line foreman to make a written report which a record clerk can enter properly on pole-card, and too expensive to have a clerk always with the linemen to note changes or additions as made. E. R. French.

Very doubtful. Should say no. ALEX. J. CAMPBELL.

(Practically concurrent opinions expressed by WARREN PARTRIDGE and F. C. S., MALDEN ELECTRIC Co.)

P 3. As good chestnut poles are becoming more difficult to obtain, what is the most satisfactory timber to use as a substitute in pole-line construction?

Cypress (red or black) makes a good pole if cut in the season when the sap is down; that is when the bark is tight and requires a knife to peel it. If the bark comes off easily, the sap is up and the pole will last but a few years, four or five being the limit.

S. S. INGMAN.

We think black cypress poles the most satisfactory substitute.

W. W. FULLER.

In different parts of the country our people are using, in place of chestnut, Michigan cedar, Iowa cedar, juniper and creosoted pine, and now are looking carefully into the question of using other timber as available in different localities.

F. S. FRANCIS.

Juniper poles are used in this section, in place of chestnut, which are becoming very difficult to obtain. Cypress is also very satisfactory; it is not quite so long-lived, but is somewhat stronger. We have sixty miles of transmission lines of juniper and cypress and find that large butts give the longest life. F. D. SAMPSON.

Michigan and Wisconsin white cedars; or, since these are becoming rarer, Idaho cedars, which are very satisfactory, indeed, if care is observed to buy no "fire-killed" poles.

H. A. STRAUSS.

Idaho cedar. E. E. SCHERMERHORN.

P 4. Is clear, hard yellow pine, Oregon fir or Maine spruce the best material for cross-arms; how do these woods compare as to strength and lasting qualities?

Clear long-leaf yellow pine is stronger, more durable and more uniform in its properties than Oregon fir or the best spruce. For these reasons I should consider the long-leaf pine preferable for cross-arms.
CHAS. W. COMSTOCK.

I believe that Oregon fir would be the most preferable material to be used for cross-arms, for the reason that it is large-growth timber and on this account can be obtained free from knots and of straight grain, clear stock. Maine spruce was fairly good material to use years ago when it was possible to obtain old-growth spruce. This is at the present time almost impossible to obtain, and spruce that is obtained at the present time checks very easily and is usually full of knots. Clear hard-yellow pine is somewhat in the same category. From information that I have been able to obtain I should judge that Oregon fir, comparing strength and lasting qualities, would more than equal the others.
F. C. S., MALDEN ELECTRIC CO.

We prefer the creosoted pine cross-arm to any other wood. The spruce cross-arms particularly, I believe, have not proven satisfactory.
F. S. FRANCIS.

From our experience, we prefer hard yellow-pine, as it give best results both as to strength and life.
W. W. FULLER.

Long-leaf yellow-pine is the best material obtainable fo cross-arms in this section. Poplar is used to some extent bu seems to become worm-eaten very quickly.
F. D. SAMPSON.

Oregon fir is preferable to hard yellow-pine or Maine spruce, being a tough wood with better lasting qualities.
E. E. SCHERMERHORN.

Yellow pine is the strongest and generally has the longest life when properly treated, but the Oregon fir and the spruce are both excellent woods.
DUGALD C. JACKSON.

P 5. Is short-leaf yellow pine creosoted as satisfactory for cross-arms as hard yellow pine painted?

Long-leaf yellow pine is slightly superior in its mechanical properties to short-leaf. In durability the difference is uncertain. Properly creosoted short-leaf pine cross-arms will last indefinitely and certainly many times longer than any painted cross-arm. The cross-arms should be framed before being treated, and should contain 10 to 12 pounds of creosote per cubic foot of timber. CHARLES W. COMSTOCK.

From information that the writer has been able to obtain from various companies, in taking this matter up quite extensively, he finds that a creosoted arm is not satisfactory. Creosoting the wood destroys the tensile strength, and it is not so good an insulation as an arm that is not creosoted but just painted. F. C. S., MALDEN ELECTRIC CO.

We use short-leaf yellow-pine creosoted, as standard throughout the country, finding that the life of this arm is much longer than of a painted cross-arm. F. S. FRANCIS.

The creosoted alternative is better; the painted cross-arms are subject to dry rot. Creosote them or put them up unpainted.
H. A. STRAUSS.

Creosoting short-leaf pine increases its life, but very materially decreases its strength. Hard yellow-pine painted is preferable for use in cities, presenting much better appearance and making stronger arms. E. E. SCHERMERHORN.

P 6. How can checking of cross-arms while being seasoned, and before being painted, be prevented?

Checking of cross-arms during seasoning would indicate carelessness in handling the timber. F. S. FRANCIS.

Time and experience are demonstrating that cross-arms should not be painted except the butt ends, which expose the cross grain of the wood fibre. C. C. GARTLAND.

To prevent the checking of cross-arms requires almost a complete study of the lumber industry. Some years ago, before the advent of so many railroads, trees, after being cut down in the forest, were hauled to the nearest stream and made up into numerous rafts. These were floated to a larger stream and from there to the river, then towed to the various cities to be sawed into timber. It is claimed by a number of experienced lumbermen that the effect of the water drove out the sap; this, in turn with the aid of the sun and wind, composed a natural curing process, which had taken at least one year's time. This, no doubt, accounts for the well-preserved appearance of some of the buildings erected in the days of our forefathers.

To-day, a tree is felled, one hour afterward it has been cut into timber and loaded on a car, and is on its way to be used in a building operation of some character—some of it for cross-arms. So it looks very much as if in these days of quick sales and small profits we pay our money and take our chances on the arms checking.

BEACON LIGHT CO.

P 7. (a) What advantage, if any, is there in the use of iron towers in place of poles for a long-distance transmission line carrying from 40 to 60 kilovolts? (b) What is the comparative first cost; maintenance cost? (c) Will not the long spans used in tower construction make the line wires break more frequently than with short-span pole construction? (d) Will towers have more or less insulating resistance than poles? (e) Will tower construction stand heavy windstorms as well as a pole line?

(a) There would be some advantage in using iron poles on account of lightning, but the excessive cost of the line would not justify them.

N. H. LEDFORD.

(a) No advantage for this small amount of energy; in fact, cost would be almost prohibitive.

(b) First cost of tower construction about twice that of pole construction, assuming first-class construction in both cases. The maintenance of tower system should be much less.

(c) Not if the wire size and constituency and length of span are carefully selected and calculated to meet the specific cases.

(d) Rely upon your insulators for insulating resistance.

(e) Better if properly constructed. H. A. STRAUSS.

P 8. Do you work on live circuits carrying a potential of 000 volts or over, and if so what precautions do you use?

We work on live circuits up to 6600 volts in dry weather only. se ordinary safety devices, such as body belt, heavy rubber loves, and mica-handled pliers, being sure that each is in perfect der and pole is perfectly dry. E. C. DEAL.

The writer has done live work upon circuits of different ltages from 5000 to 22,000 volts, but such work should be sitively discountenanced unless it is absolutely necessary. Condering the great danger of such work, if undertaken by any pern who does not fully understand the work or who does not preciate the full danger, it is undesirable to give any general les for such work. WM. B. JACKSON.

We do not consider it safe to work on lines carrying higher an 5000 volts when circuits are alive.

THE COLORADO SPRINGS ELEC. CO.

Not when the circuit is alive or carrying load. The feeder invariably disconnected at both ends, and the oil switches for ame are blocked open. The line is then securely grounded at oth ends and the work on same proceeded with.

ERNEST F. SMITH.

P 9. Do you work on dead lines attached to the same polearrying circuits at 10,000 volts or more? If so, what precautions re employed?

In dry weather good linemen can work on dead wires atched to the same poles carrying 10,000-volt circuits. The preutions ordinarily taken are the use of rubber gloves, or the actice of short-circuiting the dead wires, or both.

E. H. MATHER.

Yes, high-tension wires are above linemen, and can not be readily reached while working on other wires.

J. L. Moore.

We change insulators, put in new sections of wire, and have changed cross-arms, on a dead line with a live 33,000-volt line twenty-four inches away from it; the men working on the same set of wooden poles. This is our regular practice, and a shut-down is never made except to renew a pole itself. Circuits are three-phase, one circuit placed on each side of the pole. Each circuit is arranged in isosceles triangular form, sixty inches to a side, and the apex of the triangle upward, making two wires on the top arm, and four wires on the bottom arm. Our method is to short-circuit and ground the line on each end. When work has to be done on the line an extension ladder is used, the foot of which rests in 33,000-volt line insulators on the ground; the ladder is run up between the two lower phases on the dead line. The man doing the work on the pole ascends the ladder, having no personal protection whatever except a pair of rubber gloves to protect him from static current. He carries with him a wire with a triple terminal; the end of each terminal is fastened to a brass hook, and the hook is placed in the end of a six-foot heavy ash handle, similar to a switch stick used in the station, only heavier. This wire is carefully grounded at the ground end, and the man takes each of his handles and hooks the hook over each of the three phases; thus short-circuiting and grounding the line on which he is to work *where he can see it*. This is an extra precaution to the two short circuits and grounds already mentioned. The only real danger is in working on the phase nearest the pole, as this brings the linemen in the closest proximity to the live line, and great care must be used in the handling of wrenches, pliers and tie wires. We do not do this work in wet weather.

Farley Osgood.

We work on branch lines attached to circuits that are common to same pole line carrying two circuits, one of which is alive; in this case we temporarily ground branch line and find no difficulty in working on same at pleasure. F. D. Sampson.

P 10. Is insulation of any value on overhead lines carrying oltages between 2000 and 5000 volts?

Weatherproof insulation, if maintained in reasonably good ondition on overhead lines carrying voltages between 2000 and 000, is unquestionably of great value in protecting linemen at ll times, except when the weather is wet. Such insulation hould not, of course, be depended upon entirely, but its presnce greatly reduces the hazard. H. B. Gear.

Insulation prevents short circuits in case of accidental conact, or in case a wire is thrown over the line, and might prevent lamage claim being allowed in case of accident resulting from roken wires or crosses with telephone wires. B. J. Denman.

Insulation is of great value upon overhead lines carrying etween 2000 and 5000 volts where there is probability of limbs f trees, telephone wires, *et cætera,* falling across the wires. A irst-class triple-braid insulation will usually hold against presures of 2000 to 5000 volts when dry, and will frequently be of nuch value even when wet. Wm. B. Jackson.

Insulation is of value on wires up to 4000 volts in dry eather and is well worth the extra cost over bare wires, both r reasons of policy and safety. Any insulation on overhead ires is of doubtful value in wet weather and should not be epended upon. L. L. Elden.

Insulation on wires carrying current up to 2500 volts in dry eather would give some factor of safety in handling by lineen. With over 2500 volts, the writer thinks there is no adntage in having insulated wire, but usually the city ordinances vern this regardless of the voltage, so it is sometimes policy use an insulated wire for appearance's sake even on a 13,000-lt line. F. C. S., Malden Electric Co.

Insulation certainly is a great advantage, but linemen should trained not to depend on the insulation for safety.

The Colorado Springs Elec. Co.

Yes, if good insulation is used. If ordinary weatherproofed wire is used the insulation is valuable until it begins to deteriorate and fray, then it is worse than none, as the linemen are likely to depend upon it for protection.

If run under telegraph or telephone wires in urban communities it is, however, in general a decided protection.

H. A. Strauss.

The ordinary weatherproof insulation used on lines carrying 2000 volts or more should not be depended on, but is, sometimes at least, a certain amount of protection. F. Tobey, Jr.

Yes, weatherproof insulation does avert some trouble, but can not be relied upon for this purpose. W. T. Oviatt.

The ordinary so-called weatherproof insulation is of little value for 5000-volt lines, especially in wet weather. Linemen are not willing to trust it, and object to its being called insulation at all. W. W. Fuller.

Wire insulation is of no value for 2000-volt lines exposed to the elements, except in dry weather and when insulation is new.

N. H. Ledford.

Of very little use except to deaden a short circuit that might be caused by wires getting together. J. L. Moore.

Of some value, but not much. Fred. W. C. Bailey.

For voltage over 600 we have not found insulation of any value, except in very dry climates. J. R. Cox.

I think that insulation of any kind on high-potential lines, 1000 volts and upwards, is of little value except in dry weather. In damp or wet weather I should take the same precautions in handling live insulated lines as I should with bare wire.

F. M. Vander Voort.

It has the most salutary effect in the minds of the unsuspecting public. However, insulation on aerial lines, after two or three seasons of weather and lightning storms, is a very doubtful factor on voltages above three or four hundred.

F. D. SAMPSON.

Legally, it would probably have some value. Practically, it would not have any, unless it were some special insulation made for this pressure. It is sometimes necessary in stringing wires to run them over other working lines; in such cases it would have considerable value. BEACON LIGHT CO.

It cost our company $10,000 to find out that ordinary weatherproof insulation is not much protection in wet weather on 2000 volts. W. H. FELLOWS.

Ordinary triple-braid weatherproof wire insulation is of no value whatever on overhead lines carrying over 2000 volts. You might as well use bare wire. E. C. DEAL.

P 11. Should wire insulation be maintained on overhead city wires carrying more than 2000 volts?

States should pass laws prohibiting the use of insulated wires for pole-line work, where the pressure exceeds 500 volts.

N. H. LEDFORD.

We are operating a 6600-volt circuit through the city, consisting of No. 4 bare wires. This line is on 60 and 75-foot poles and goes over everything. It has been in use three years and has caused no trouble of any kind thus far. We are of the opinion that it would be a useless expense to insulate these wires.

W. H. FELLOWS.

Yes. With over 5000 volts use tall poles and bare wires, except for arc circuits. FRED. W. C. BAILEY.

Ordinary insulation is of little service. However, an insulation that will withstand the higher voltages, say, 2000 to 5000 volts, is desirable, and should be used on overhead city lines.

W. W. FULLER.

Yes; but have it reinsulated when insulation begins to fray.
H. A. Strauss.

This, I think, has been covered in answer to P 10.
F. C. S., Malden Electric Co.

P 12. A ten-mile line of three No. 8 triple-braid weatherproof copper wire, built two years ago, has been tied in with No. 10 galvanized-iron wire. Would you recommend changing ties to No. 8 triple-braid copper at the present time? No trouble has as yet developed.

The use of insulated wire for ties is advisable in all cases, and is imperative in some localities where local action takes place between the ties and the line wires, due to climatic and static conditions. It would add a considerable insurance factor to the operation of the line in question to remove the iron tie-wires and replace with insulated ties. L. L. Elden.

Such methods of tying-in are certainly contrary to good practice. It may be only a question of time, and possibly a short time, when trouble will develop, and when trouble starts it may show up all along the line. To be safe, it certainly would be advisable to tie the line properly.
The Colorado Springs Electric Co.

It will give you no trouble provided the insulators are all right, for if the triple-braid weatherproof insulation comes off and your ties hold, you have to depend on the insulator any way. Surface leakage, except on high-voltages, would be *nil*.
F. D. Sampson.

The platform adopted by a political convention in Kansas might serve as an answer to this question. It reads as follows: "Leave well enough alone." M. C. Turpin.

No; you need hardly look for trouble. H. A. Strauss.

P 13. In 2300-volt overhead suburban and semi-suburban stribution, where the circuits extend over considerable territory, d with numerous branches, should primary fuses be placed in ery branch, or only in the more important branches, or should otection be relied upon solely in the switchboard circuit fuses?

I do not think it is policy to fuse branches on suburban or emi-suburban distribution. In one plant covering four cities nd a large area, we use no fuses at all, simply oil circuit-break- rs at the switchboard at plant. We have never yet seen where- n fuses would be of any advantage. Some eight years ago, hen the writer first became connected with the plant, they had ich equipment and it caused more interruptions of service in a ear's time than we have had in the past seven years without it. Ve are using a small oil-switch on large branches from the main nes so in case of wires down or repairs that can not be made ithout cutting the line off, these branches can be easily cut out f service.

F. C. S., Malden Electric Co.

Primary fuses or their equivalent should be placed on all nportant branches, and on all branches, whether important or ot, where the physical conditions of the lines suggest possible terruptions of service from trees or other causes. The sta- on protective devices should be made to care only for severe oubles.

L. L. Elden.

We make it a practice to put fuses on each branch line, and the main line is very long and runs through many trees, put itouts in that, so as to divide up the line into sections. We d this saves considerable trouble in confining line troubles to small a radius as possible. It also permits cutting out certain ctions in case of repairs with the minimum disturbance to stomers.

S. S. Ingman.

Primary fuses should be placed in all branch circuits. Switch- ard fuses are considerably in excess of the capacity of branch cuits. If branch circuits are short, one set of fuses may be talled to protect a certain territory.

W. H. Greenslit.

If branch circuits extend very far from the main line and are below other wires, or through a district where the trees interfere, they should be fused. Branch circuits at all times should be tapped through a fuse box. If not necessary to fuse, use wire instead, then should it become necessary to cut off a section for any purpose, it can be done without interfering with the main line. BEACON LIGHT CO.

We have found it better to put primary fuses in for all the distant and outlying districts, especially where the lines are subject to trouble from wind storms with only a part of one circuit out of commission. It also makes it much easier to locate troubles on the line. H. D. LARRABEE.

We should have cutouts on every branch to facilitate testing for trouble. Whether they should be fused or not is a matter of taste as to whether you want to put in a lot of fuses after each lightning storm. I should not fuse lighter than 50 per cent overload, as I find that a reliable station circuit-breaker will go out before this blows during a discharge, and service is renewed immediately on closing the station-breaker. F. M. VANDER VOORT.

Should use branch blocks or primary fuses, for every branch of any importance. It will be found very convenient in locating and repairing line troubles, and frequently will confine interruptions of service to smaller sections. F. TOBEY, JR.

(Practically concurrent opinions expressed by E. H. MATHER, N. H. LEDFORD, F. D. SAMPSON.)

Primary fuses should be placed only in the more important branches, except where small branches run through trees or are otherwise exposed to unusual risk of short circuit. The number of fuses employed should be the least possible. H. B. GEAR.

Primary fuses should be placed only in the more important branches and special care should be exercised as to the proper size of fuses to be used in these branches. E. C. DEAL.

(Practically concurrent opinions expressed by FRED. W. C. BAILEY, W. W. FULLER, H. A. STRAUSS.)

Fuse only important branches, but provide all branches with junction boxes for convenience in testing. E. R. French.

We fuse all branch lines that pass through trees or anything else likely to cause trouble. W. H. Fellows.
Warren Partridge.

I have tried fusing several of the branch circuits with single-pole porcelain junction plug boxes and find that the best satisfaction is given by not having the branch circuits fused. Let the station fuse take care of them. However, we have found it very satisfactory to fuse the plugs with heavy copper wire. This makes it handy and safe to disconnect a section for repairs instead of having to shut off the current to cut and re-connect the whole line. F. W. Bullock.

We consider it the best policy to fuse distribution feeders at one point, namely, the plant or substation. Thus a fuse can be quickly replaced with a minimum shut-down. However, it is a good scheme to have means of disconnecting branches in order to locate trouble of a continuous nature, so that the troubled branch may be cut and not interfere with the rest of the circuit.
The Colorado Springs Electric Co.

On switchboard only; but there should be copper-fused cut-out boxes placed at junctions, by which different sections can be cut out to locate trouble. J. L. Moore.

I would recommend that you depend upon the switchboard circuit-breaker, as the more branch fuses you put on your line the more trouble you are likely to have, on account of the boxes not being good enough in construction. J. J. Gaffney.

P 14. Where a network of secondaries is tied in together, is it advisable to fuse the section covered by each transformer and, if so, what relation should the size of fuse have to the secondary?

It is advisable to use section fuses, also fuse secondary lead of transformer, using a fuse slightly in excess of transformer capacity. Use section fuse half the capacity of transformer. If secondary system is properly balanced very little current will pass through the fuses under ordinary conditions, but in case of a short circuit on any section, when all transformers are operating at full load, a momentary 50-per cent overload on the transformers of adjoining sections will cause the sectional fuses to blow, consequently cutting out the defective section. I am supposing that all transformers are of the same size. Care should also be taken in properly fusing primary side of transformers in use on such a system. E. C. DEAL.

When a network of secondaries is tied together it is advisable to fuse the section covered by each transformer. The fuse should bear some relation to the size of the transformer, being about half the capacity of the transformer; the idea being that should the fuses on one transformer blow, the fuses in secondaries will blow, thus indicating, by lights being out, that this section's transformer fuses are blown. Otherwise, transformer fuses may be out and a long length of secondary fed by those transformers whose fuses are still holding, thus giving poor service on the end of the secondary. PAUL F. WILLIAMS.

Fusing each section is not done as a rule. However, there are cases when it may prove valuable. The neutral point, or rather the point (between transformers tied together) which carries minimum current at all times, is the place for the fuse. It should have capacity enough to carry the current flow caused by irregularities and changes in load in either section, and should be small enough to protect either transformer from excess load if the opposite transformer for any reason fails.

W. H. GREENSLIT.

After a number of years' experience under all sorts of conditions it has been found advisable to fuse only the primary side of transformers on a network. Fuses are installed ordinarily which represent a 100 per cent overload on each transformer. L. L. ELDEN.

Fuse each section and let fuse have a capacity about equal to 75 per cent above normal full-load transformer current.

H. A. STRAUSS.

P 15. Is the Y-connection with grounded neutral preferable to the Delta-connection in a high-tension transmission line, and if so, why?

The writer is of the opinion that for all high-tension, three-phase transmission lines, of reasonable pressure, the delta connection is far more desirable than the Y connection, for the reason that it makes it possible to remove any one of the step-up or step-down transformers without interfering with the operation of the system, thus making it so that a transformer may remove itself by opening the protective devices without interfering with the service. The delta arrangement also makes it possible to have a simpler arrangement for cutting in a reserve transformer than with the Y connection. WM. B. JACKSON.

The relative importance of certain advantages and disadvantages of the Y and delta connections on high-tension transmission lines is a matter of some dispute. The delta is generally used for straight three-wire, three-phase work up to 20,000 volts, but for very high voltage the Y connection with grounded neutral seems to be preferred, as the rise in pressure on open or short circuit is not so dangerous and the grounded neutral assists unbalancing. FRED. W. C. BAILEY.

By using Y connection the transformers only have to be wound for $\frac{1}{\sqrt{3}}$ line voltage, consequently, the transformers are cheaper on account of less insulation. In other words, it lessens the voltage across each transformer. M. C. TURPIN.

Some of the largest plants recently designed expect to use delta connection throughout. This company operates everything thus connected and there has been no trouble directly traceable to the delta connection. With proper break-down tests made by manufacturers upon line insulators, transformers, oil switches and alternators, the delta connection will remain the more popular connection in three-phase transmission work. The great advantage of the delta connection lies in the fact that you are able to cut a transformer in or out of service without interruption. This is a salient feature where the number of transformers is limited. Grounded neutrals are all right theoretically, but the fact still remains that with the opening of the high-tension circuits they will cause currents to flow to earth. Telephone service is very likely to be interfered with, with grounded neutrals or Y-connected systems. F. D. SAMPSON.

If Y is operated with grounded neutral it is safer than delta, because the difference of potential between coils and core is limited to 58 per cent of the line voltage.

Y-connected transformers are somewhat cheaper than delta-connected. If transformers are to be operated without grounded neutral the delta is more satisfactory, because operation is not impossible if one transformer of the delta is in trouble or burned out, which is the case when one transformer of a Y is out of service.

In general, use delta in all cases except where it becomes necessary to limit the voltage per transformer when Y-connection may become imperative, but if you use Y, operate with grounded neutral. H. A. STRAUSS.

Yes; at the generating end.

First, because it reduces the voltage strain to ground.

Second, it decreases the liability of any serious effects that may be caused by rise of voltage, due to a short circuit or an open circuit.

At the receiving end of line a delta connection of transformers is often preferable. C. A. KELLER.

P 16. Do you voluntarily open your lines during severe lightning storms, or just preceding them?

We have done so during very severe electric storms, but never until after the storm had developed. F. TOBEY, JR.

On 2200 volts have tried both ways and think that it is better to leave lines working during lightning storms. Have plenty

of good lightning arresters on lines and in station and be sure of good ground connections, also that lightning arresters are kept clean.
F. W. BULLOCK.

We do not open our circuits at all during a lightning storm. We rely upon our arresters for protection. We are located in a section subject to many violent electric storms in the summer time, but have experienced no station trouble from lightning other than the loss of a few arresters.
E. C. DEAL.

Install sufficient lightning arresters, with ample ground connections, and never open a line, for it will lead the public to a very poor impression of the reliability of central-station service.
BEACON LIGHT CO.

No. We rely upon efficient action of lightning arresters and time-limit overload relays for protection during severe lightning storms.
ERNEST F. SMITH.

Never open lines unless absolutely necessary, due to shorts or ground, and never then if possible to burn them off.
GEO. N. TIDD.

No; we are in the business to give service. If service is found insufficiently protected, put on more breastwork in the form of lightning arresters.
C. C. GARTLAND.

No; put on a sufficient number of good lightning arresters so that you will "feel" safe and then take a chance. Opening your circuits brings electric light and power service into disrepute.
L. W. GREENE.

We never take our circuits off and rarely have the station fuses blown by an electric storm.
W. H. FELLOWS.

We have severe lightning storms, but the necessities of the service are such that we run through storms and do not shut down voluntarily. We do not consider such operation a dangerous risk to apparatus.
THE COLORADO SPRINGS ELECTRIC CO.

Our rule is to never open any lines preceding a lightning storm or during a lightning storm. We depend entirely on the lightning arresters for protection. J. J. GAFFNEY.

No. In fourteen years' operating I have never opened the line either before or during a storm. A. O. FRETZ.

No interruption of service is made unless it is impossible to keep the lines in service on account of the severity of the storm.
L. L. ELDEN.

We have never, in any of the plants with which the writer is connected, cut off any of our circuits during severe lightning storms, and have never lost any apparatus, with the exception of a few transformers, in the last seven years.
F. C. S., MALDEN ELECTRIC CO.

No. ANDREW F. HALL.

P 17. (a) Do you permit joint occupancy between telephone, telegraph and fire-alarm wires with electric light feeders? (b) Is such joint occupancy required by the city or town authorities?

We permit joint occupancy of our pole lines and believe in it. If two telephone companies, a traction company, a telegraph company and an electric light company must have separate pole lines it mars the beauty of all the streets, increases the danger from crosses between wires and hastens the time when everything of the kind must be put under ground. A. T. LLOYD.

There is less danger of accidents to persons and property from joint occupancy of poles by telephone, telegraph and electric light companies, provided the electric light wires are placed on the upper cross-arms, than under any other form of construction. Under this plan the leaning of poles one way or the other does not cause cross contacts, and telephone and telegraph linemen have no occasion to go up poles far enough to come into contact with electric light wires. The telephone and telegraph wires can do but little, if any, damage in case they break and fall to the streets. E. H. MATHER.

In three towns in which the writer has had operating experience the joint occupancy by the telephone, telegraph and fire-alarm wires with the electric light feeders was approved and the writer believes that such joint occupancy is far more desirable than the use of two or more pole lines upon the same side of the street, as is seen in many towns. In none of the towns referred to was joint occupancy required by the city authorities, though the electric company frequently made efforts to have such a requirement. WM. B. JACKSON.

Nearly all towns and cities require space reserved on poles for fire-alarm wires, and in a majority of cases poles are used jointly for all purposes, telephone, telegraph, railroad, fire-alarm and electric lighting service, under the rules of the National Board of Fire Underwriters and the local insurance boards.

L. L. ELDEN.

(a) In some cases we use poles jointly with the electric-light feeders. We do not like to go on poles carrying a circuit higher than 2200 volts, and avoid this wherever possible.

(b) In Philadelphia the companies operating pole lines are required to furnish one gain at the top of the pole for the use of police and fire-alarm, telephone and telegraph circuits and the city uses electric light and telephone poles apparently indiscriminately for the service. We have very few cases where joint occupancy by telephone and electric light companies is required.

F. S. FRANCIS.

We are required to furnish space on our poles for fire and police-patrol wires. Aside from this the telephone company uses our poles, and *vice versa,* in many instances by mutual agreement.

THE COLORADO SPRINGS ELECTRIC CO.

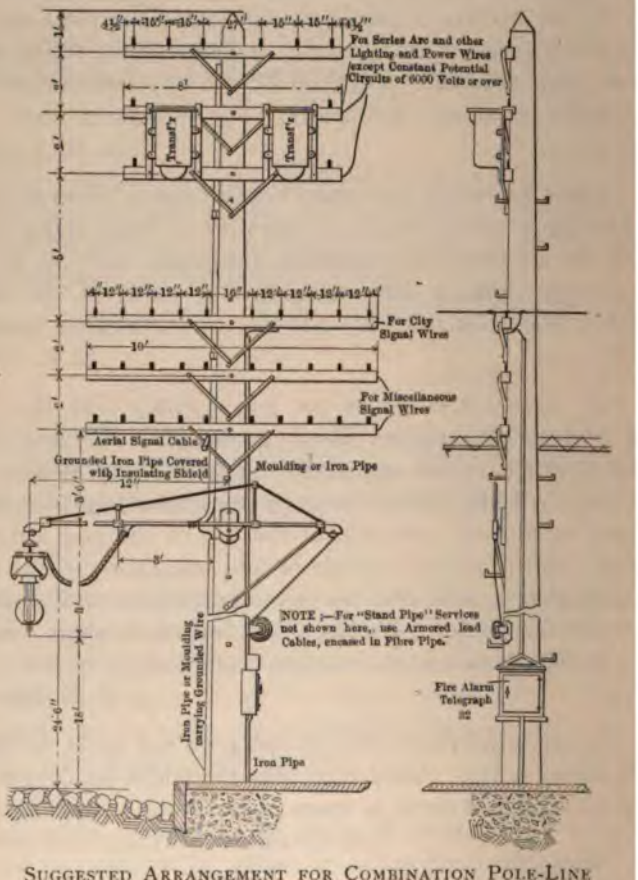
(a) Yes.

(b) No; with the exception that for our privilege of maintaining pole lines we are obliged to leave the top gain of every pole for the city. This is rarely used, however, as city prefers to occupy the telephone poles wherever possible.

F. C. S., MALDEN ELECTRIC CO.

Joint occupancy is required in many cases by city in ord reduce the number of poles on streets. We construct these bination poles under the following specifications:

Bureau of Electricity and Gas, Clarkson Street, specifica for combination line.


4½″
15″
15″
27″
15″
15″
4½″
1′
2′
2′
5′
2′
2′
8′
For Series Arc and other Lighting and Power Wires except Constant Potential Circuits of 6000 Volts or over
Transf'r
Transf'r
4″
12″
12″
12″
12″
16″
12″
12″
12″
12″
4″
10′
For City Signal Wires
For Miscellaneous Signal Wires
Aerial Signal Cable
Grounded Iron Pipe Covered with Insulating Shield
12″
Moulding or Iron Pipe
3′6″
8′
3′
24′-6″
18′
Iron Pipe or Moulding carrying Grounded Wire
Iron Pipe
Fire Alarm Telegraph
32

NOTE:—For "Stand Pipe" Services not shown here, use Armored lead Cables, encased in Fibre Pipe.

Suggested Arrangement for Combination Pole-Line Construction

1. Poles to be chestnut, peeled, roofed and painted, 45 fe length and set six and one-half feet in ground.

2. They shall carry in the three upper gains, which sha respectively, 1 foot, 3 feet and 5 feet below the peak of the

cross-arms to accommodate electric light and power wires and, when necessary, transformers (same to be placed on insulated attachments).

3. In the remaining gains, of which there shall be three, placed, respectively, 10 feet, 12 feet and 14 feet below the peak of the pole, shall be placed the standard 10-pin cross-arms of the New York and New Jersey Telephone Company, the pole-pins of which shall be removed, leaving sufficient clearance for a lineman to pass through without interference. The upper arm to be used by the police and fire departments, and the remaining arms for other signal purposes.

4. In the event of necessity for electric light and power wires to pass down the pole for any purpose whatever, said wires shall themselves be properly insulated and contained in a properly-grounded iron pipe, or other grounded metallic shield to be securely attached to pole. The ground wire extending from the enclosing pipe to the ground to be properly encased in a wooden moulding or iron pipe from the point where it leaves the pipe enclosing the electric light and power circuits to a point six inches below the surface of the ground.

5. In the event of necessity for adding an aerial cable to the line, the cable shall be hung from a messenger wire (supported on one side of the pole), and the messenger wire and cable sheath shall be suitably grounded at points about 1000 feet apart.

Diagram herewith shows requirements.

THE BROOKLYN EDISON, W. K. SPARROW.

We do. The city authorities require it in the case of fire-alarm wires. We also think that by trying to confine the number of poles on the streets to the minimum we best serve our own interests. F. TOBEY, JR.

New York and New Jersey Telephone Company requires power or lighting wires to be five feet below their lowest cross-arm, the use of 10,000-volt insulators and transpositions. I doubt the efficiency of the transpositions. F. M. VANDER VOORT.

(a) Joint occupancy permitted by the city authorities and we have a joint agreement with the telephone company, also an agreement with telegraph company for joint use of poles.

(b) Such joint occupancy has been required by the city authorities. W. E. H.

In some cases we jointly occupy poles with telephone wires. (b) We are required to carry city fire-alarm wires on our poles. LUDWIG KEMPER.

Electric light feeders and fire-alarm wires. Town has right to position on poles of company. ANDREW F. HALL.

Not as a rule. However, the city directs, by ordinance, joint occupancy of poles when a new pole line is erected in the heart of the city. F. D. SAMPSON.

(a) Yes.
(b) No. ALEX. J. CAMPBELL.

We discourage it, but fire alarm has the right under our franchise. R. N. KIMBALL.

No. TOLEDO RAILWAYS AND LT. CO.

P 18. In case of joint occupancy of pole lines, what requirements do you make as to the responsibility for accidents, standards of construction, etc., that are imposed on the telephone and telegraph companies?

In case of joint occupancy of poles by telephone, telegraph and electric light companies, each corporation should be liable for accidents caused by its own lines. Standards of construction should be agreed upon so as to make pole lines uniform in appearance, and repairs simple. E. H. MATHER.

In cases of joint occupancy on poles with electric light companies our general practice is to hold each company responsible for the condition of its own construction and for accidents that may be caused by the presence of that construction. In the majority of cases, the ownership and maintenance of the pole itself and the consequent responsibility are vested definitely in one or the other of the companies. In the few cases where a pole is owned jointly, a special agreement covering the maintenance and responsibility is entered into with the electric light company.

F. S. FRANCIS.

Construction of other wires on our poles must be satisfactory to us. We leave the question of responsibility to the courts, where it will usually come in any event. F. TOBEY, JR.

We carry public and employees' liability insurance. We always leave the two inside pins free on any cross-arm, so that linemen can go up and down easily. R. N. KIMBALL.

In case of joint occupancy of pole line each company is responsible for accidents due to defects in their wires or works. It has been easy for us to agree on standards of construction before building a joint line, but where a line belonging to one party is already built and the other party wishes to come in and make it a joint line, the party coming in last must rebuild the line, so that it may be strong enough to accommodate both parties to the agreement. W. E. H.

P 19. (a) Do you operate telephone circuits over the same pole line that carries high-tension transmission? (b) Is the telephone service satisfactory? (c) What precautions are employed at the instruments?

We have 26-mile, 33,000-volt transmission line of three No. 5 hard-drawn copper in triangle 36 inches apart. On the poles, 30 inches below 33,000-volt wires, we have private telephone line No. 10 galvanized-iron, spaced 20 inches, transposed every third pole. We use Connecticut Electric Manufacturing Company's 'phones and have excellent service. We bring telephone line into building and to booth on regular high-tension Thomas's insulators. The booths are set on high-tension insulators, and are kept away from walls. We also have a small platform, insulated

(c) We use fuses and switches at each instrument, also air gap grounded on one line, and insulated platform for employees.
F. D. SAMPSON.

(b) Transpose your high-tension lines if you carry telephones on the same pole line.

(c) Fuse every instrument by means of two single-pole fuses in a separate box above every instrument. H. A. STRAUSS.

We have a number of telephone circuits operated over the same pole line that carries high-tension transmission at 6900 volts. You would not know, from listening on the telephone lines, that there were two three-phase transmission lines on the same pole. At the same time we do not believe that it is advisable to have telephone wires on the same poles with this high-tension transmission, and the telephone companies are removing them as fast as possible. W. E. H.

(a) Yes. (b) Yes. (c) None. B. A. SCHAK.

P 20. What kind of safety devices are generally used by linemen working on 2300-volt lines?

We use oil switches in the branches from our main lines, and if the services on these branches are not very important as to cutting off for a short time, these switches are opened during the time of making necessary repairs. Linemen are instructed to treat every wire as if it were alive, and in all cases to use rubber gloves, which are furnished by the company.
F. C. S., MALDEN ELECTRIC CO.

Linemen working on 2300-volt lines should be provided with good rubber gloves, and in damp weather it is safer to take the extra precaution of using either kid or woolen gloves inside of the rubber. E. H. MATHER.

Safety belt, rubber gloves, mica-handled pliers, in ordinary weather. In wet weather it is necessary also to wear rubber

boots, and this, too, is materially improved by the lineman using a thin rubber slip on his foot and over which he pulls his sock.
E. C. DEAL.

On wooden poles, rubber gloves seem to answer the purpose of protecting lineman. Mica or rubber-handled tools are advisable also.
S. S. INGMAN.

We know of no other safety device than rubber gloves with buckskin glove outside.
W. E. H.

Rubber gloves are the only safety devices found necessary for this work.
L. L. ELDEN.

None except the watchfulness and care of the individual lineman.
THE COLORADO SPRINGS ELEC. CO.

P 21. Which is the better practice in cases of joint occupancy of pole lines—to have telegraph and telephone wires above and electric light wires and feeders below, or vice versa? Give the reason why.

Place arc circuits and primaries above telephone and telegraph wires, with three or four feet distance between. Secondary or heavy direct-current feeders may be placed, with advantage, below telephone wires. Carry leads to transformers down pole with rubber-covered wire in pipe. Telephone wires are more liable to trouble and breakage than primaries, and if dropped across primaries will lead high-tension current into numerous offices and residences over wires having low-insulation resistance, within easy reach, with consequent great danger to the public. A telephone wire falling on secondaries will be promptly burned off if insulation is bad. If insulation is fairly good, the trouble on telephone line may be corrected before insulation on secondaries is broken down. Telephones in any case will be very likely to burn out. With arc circuits and primaries above telephone wires, the telephone linemen are not forced to climb through high-tension wiring.
FRED. W. C. BAILEY.

In case of joint occupancy of pole lines, the telephone company prefers the lower location on the pole. This is on account of:

First—The danger to telephone company's linemen, who, as a rule, are not familiar with the power company's circuits.

Second—The larger amount of work in adding new circuits, *et cætera*, being done by telephone company on the line. If additional telephone wires have to be strung above the power circuit, the danger of a cross and consequent damage is increased.

Third—The greater tensile strength of wire used for power circuits; in case of severe sleet or other abnormal conditions on the line the telephone wires generally fail first. Under these conditions, if the telephone wires were above, the liability to high-tension crosses and consequent trouble and damage is much increased. F. S. Francis.

From the standpoint of the electric light company it is preferable to have the telephone wires above the electric light wires in the case of distributing circuits, owing to the greater ease in making frequent connections to the circuits, installing transformers, lamp fixtures, *et cætera,* without having to interfere with or pass relatively high-potential wires up through the telephone wires. In the case of long-transmission line it would be preferable to have the telephone wire below the high-potential wires, as there would be no connections to be made to the line, and, as built to-day, very little liability of the transmission line to be broken and fall on the telephone wires. L. L. Elden.

Where there are few trees or none I think it decidedly the better practice to put the electric light wires above everything, for the reason that telephone and telegraph wires are generally more numerous, are worked on more by linemen and are subject to breaking oftener than the lighting wires. Where there is a 24-hour service it is still more desirable. I have practiced both ways, however, and when lighting wires were run beneath the others I used long cross-arms so that linemen would be less likely to come into contact with the wires when passing to those overhead. S. S. Ingman.

In the joint occupancy of poles the electric light wires and feeders should be above the telephone and telegraph wires, because they are mechanically stronger and less likely to break and come in contact with the telephone and telegraph wires; further, because the electric light linemen are the only ones who have occasion to go up the poles far enough to come into contact with electric light wires. E. H. MATHER.

(Practically concurrent opinions expressed by H. B. GEAR, B. J. DENMAN, E. R. FRENCH, J. L. MOORE, T. H. T. & L. Co., ERNEST F. SMITH, BEACON LIGHT CO., W. H. FELLOWS, A. T. LLOYD.)

In case of joint occupancy of poles we consider it better practice to have the telephone and telegraph wires above the electric light wires and feeders, for the reason that the metal employed by the electric company is usually much heavier than the metal employed by the telephone and telegraph companies, and if this large amount of copper were placed high on the poles it would often increase the strain to a dangerous extent. It is inadvisable to put transformers, main-line cutouts, and so forth, at the top of poles, neither is it advisable to bring the leads for these devices down through the telephone wires. W. E. H.

This question was answered very fully under P 27, Volume II, of the 1905 proceedings. ALEX. J. CAMPBELL.

P 22. A three-phase, 2200-volt, 60-cycle line about seven miles long running parallel to a telephone line continually has a heavy static charge. What is the best way to overcome this?

The installation of some of the standard spark gaps or static discharge apparatus in several locations on the line would relieve the line of its charge periodically as it rose to a sufficient value to discharge across the spark gaps. L. L. ELDEN.
RALPH R. LAXTON.

The best way to overcome static effect is by means of properly placed and adjusted lightning arresters. This will dissipate the static charge. W. E. H.

Try transposing your three-phase line, if you have not already done so. Such procedure should at least reduce this trouble.

F. D. Sampson.
M. C. Turpin.

P 23. Does your company supply service switch and cutout on overhead distribution? Do you find this practice advantageous?

We do not supply service switch and cutout on overhead or underground distribution. We do not think the practice of supplying them free to the customer advantageous. W. E. H.

F. C. S., Malden Electric Co.

We do not supply service switch and cutout, but require switch and cutout to be on all installations connected.

The Colorado Springs Elec. Co.

We require service cutout and switch on overhead construction and supply same to consumers at cost. Ludwig Kemper.

No. It keeps down investment in services and does not antagonize wiring contractors. B. J. Denman.

The service switch and cutout should be furnished by the party who owns the building, as it is a part of the inside wiring system. E. H. Mather.

No. We connect to wires extended out of building by contractor who furnishes main switch and cutout. E. R. French.

No. S. S. Ingman.

Usually the consumer pays for all material used in connection with the inside wiring; sometimes it is advisable, in order to gain a good consumer, to install service switch and cutout free.

The Beacon Light Co.

P 24. Does your experience in the supply of current in districts where there is no underground service show the advisability of using an alternating or a direct-current system for the supply of current to motors? Why? What is the best system?

For supplying current to motors an alternating system should be used, because the power can be transmitted at higher potential and, therefore, with less loss; further, because the alternating motor is simpler and more economical for the customer to maintain. Where lights are to be used from the same circuits that supply motors, the three-phase system is, perhaps, the most satisfactory in large cities, and the two-phase system in small cities or towns. E. H. MATHER.

To answer this question properly, I think it would be necessary to give some specific case, as the distance is the feature that must be considered in the advisability of using alternating current. Leaving this feature aside, the writer thinks that the alternating current is preferable, as the alternating motor is a much simpler and more reliable motor than the direct current for general use. F. C. S., MALDEN ELECTRIC CO.

With the exception of apparatus requiring variable speeds, the alternating-current system furnishes a most satisfactory power service. Careful attention to special demands that are not readily adapted to the alternating-current service will usually result in the development of apparatus to meet the emergency satisfactorily. Three-phase service for motors of large capacity and single-phase service for small motors seems to be the preferable and most satisfactory system to employ. L. L. ELDEN.

If both alternating and direct three-wire current are supplied from plant, it is largely a question of the relative copper to reach the motors. Alternating-current motors are best served on power feeders independent from the lighting. Small single-phase motors may be connected with advantage to alternating-current secondary mains. FRED. W. C. BAILEY.

In general, an alternating-current system is preferable, e pecially where the supply covers a large district. The three-phas four-wire, 60-cycle system, with 2300 volts between phase an neutral, is the best system for nearly all conditions when a alternating system will satisfy commercial demands.

C. A. KELLER.

Use alternating current if motors are of small size, say fiv horse-power or less; connect them all on same secondaries, whic should be three-wire, 115-230 volts; all motors two-horse-powe or over, to be 230 volts. Use ample transformer capacity to as sure good regulation—2400-volt, 60-cycle, three-wire, two-phas

BEACON LIGHT CO.

It is impossible to class one system above the other for a purposes. From the station man's standpoint, the alternating current system is probably the more desirable, but in almost ever community there will be found a certain class of industries de manding wide ranges of speed control in the application of powe and these conditions are best met with the direct-current systen

RALPH R. LAXTON.

Think direct current preferable for the condition cited, unles area of distribution is too great to give satisfactory economy wit 500-volt direct-current service, principally because direct-curren motors permit of simpler and more satisfactory arrangements fo speed variations.

H. A. STRAUSS.

We have a direct-current power system installed. Withi limits of territory covered by this service we require direct-curren motors. In outlying districts the alternating-current motors ma be used. It is an open question as to which is the better system, a so many conditions enter into the case.

THE COLORADO SPRINGS ELEC. CO.

Very satisfactory results are obtained by the use of overhea three-wire direct-current system in densely loaded territory o limited extent adjacent to converting substations, with large mo tors connected to outers and small motors connected between neutral and either outer. In extended territory where the load density is low, three-phase four-wire, 2400-4150-volt, 60-cycle system is very satisfactory. Large motors of the three-phase type are connected between the three-phase wires, while small single-phase motors are connected between the neutral and the respective phase wire. ERNEST F. SMITH.

My experience shows that direct current is preferable for the supply of motors where the amount of business will warrant the copper investment. Why? Because our customers on the overhead direct-current system have suffered no interruption of service except in cases of fire. F. J. P. SERREL.

P 25. What is the greatest radius commercially practicable for a 110-220-volt three-wire direct-current system?

Moderate amounts of current can be delivered economically by a 110-220-volt, three-wire system over a radius of from 2500 to 3000 feet. After this limit is reached it is usually found advisable to install new distributing substations. In districts where large amounts of current are distributed it becomes, in many cities, more economical to limit the distributing radius to from 1000 to 1500 feet, or even less. L. L. ELDEN.

The greatest economical radius is determined by the distribution of load and the fuel costs, which largely determine the copper. The greatest economical radius will be from 4000 to 7000 feet. FRED. W. C. BAILEY.

The maximum practicable radius for a 110-120-volt system depends upon the distribution and extent of the load, and the revenue derived. If the revenue derived from the system permits the installation of a large amount of copper per 50-watt lamp, then the practical radius of distribution is great. In his *Electrical Transmission of Energy*, Art. 599, Mr. A. V. Abbott gives a table showing the radii of profitable districts that may be served with five per cent drop in pressure—for installations with 12.5 pounds and twenty-five pounds of copper per 50-watt lamp. The following are the figures given for a three-wire feeder and main

	Radius Profitable District with 5 per cent drop	
	Copper 12½ pounds per 50-watt lamp	Copper 25 pounds per 50-watt lamp
Three-wire system	2300 feet	3500 feet
Three-wire feeder and main	4000 feet	6000 feet

Experience in general indicates that economical radius is less than given, especially where load is dense, as in very large cities.

P. S. BIEGLER.

Four square miles seems to us about the limit, and even within that radius the cost of copper makes the economy of such distribution seem questionable. E. A. VAUGHAN.

Probably one-half to three-quarters of a mile is the limit within which this system can successfully compete with alternating current. RALPH R. LAXTON.

A. PETERS.

The alternating-current system has become so flexible in the last few years that unless there are some very peculiar conditions it will meet all requirements. THE BEACON LIGHT CO.

P 26. Assuming that in the use of four-pin cross-arms for single-phase work the ideal method of construction is to run the two wires on adjacent pins on the same side of the pole, is the saving in inductive loss effected thereby sufficient to warrant the increased cost of construction for guying arms that is made necessary when the above rule is followed for both primary and secondary work? 2000-volt primary, 110-volt secondary; population of the town 35,000.

In 2000-volt primary distribution the increased inductive drop due to carrying wires on opposite sides of the pole instead of on the same side is generally so small as to be negligible with all sizes of wire smaller than No. 0 B. & S. With wires from No. 0 to No. 0000, if the drop with 12-inch centres is 10 per cent, the drop with 24-inch centres would be about 11.5 per cent. With means for independent feeder regulation at the station this additional drop would not warrant any increased cost for construction made necessary by keeping all wires on one side of the pole.

On a 110-volt secondary of No. 0000 wire, on which there was a drop of two per cent with 12-inch centres, the drop would be increased to about 2.3 per cent by increasing the centres to 24 inches. This would not ordinarily warrant any increased expense for line construction to keep the wires close together.

H. B. GEAR.

All single-phase circuits of either 125 or 60-cycle frequencies should be placed on adjacent pins on same side of pole with four-pin arms. The increased cost of construction, if any, should not determine the practice in this case, the inductive losses, assuming a certain size of wire for a given length would be material, dependent upon the spacing of the wires of the same circuit. You would have perceptible pulsations in other arrangement if you happened to be operating two single-phase alternators at the same time on the two circuits strung parallel on the same pole.

F. D. SAMPSON.

I think decidedly more would be gained by maintaining the usual arrangement and changing over the secondary system to 110-220-volt, three-wire. Ground neutral every 250 feet for protection against cross with primary or punctured transformer. The saving in inductive loss could be figured only in the light of detailed information as to size of wire, load, distance, *et cætera.* This would probably be but a small fraction of the gain by doubling the secondary voltage.

RALPH R. LAXTON.

Saving in inductive losses is only a part of it. Four-pin arms should be well braced, as you can not always tell how heavy the work will be.

H. E. RYDER.

It is certainly advisable to run the two wires of an alternating-current single-phase line on adjacent pins, both primary and secondary. If the cross-arms are properly bolted to the pole and braced, there is very rarely the necessity of using cross-arm guys.

A. T. BEAUREGARD.

Unless the conditions are somewhat unusual, the inductive loss would not be serious if the primary wires were placed on the outside pins of the four-pin cross-arms described in the question. Dugald C. Jackson.

P 27. In three-wire secondaries, if outside wires are No. 2 B. & S. gauge, what should the neutral be?

In three-wire secondaries where outside wires are No. 2 B. & S. gauge, the neutral should also be No. 2. I infer that this is an overhead secondary system to which new business is being connected from time to time. It is impossible in practical operation to maintain balance on a three-wire secondary on a commercial system of any size. It is therefore advisable to make all three wires the same size when outside wires are not larger than No. 2 B. & S. gauge. Paul F. Williams.

(Practically concurrent opinions expressed by A. W. Zahm and A. Peters.)

In three-wire secondaries, where the outside wires are No. 2, the size of the neutral depends on to what extent the sides are unbalanced. I should think that a No. 6 wire would suffice, or if the sides are very much unbalanced use a No. 4 wire.

Samuel Kahn.
Ralph R. Laxton.

It depends upon the nature of the load. If very well balanced No. 6 will be ample. Beacon Light Co.

If outside wires are No. 2, it is advisable to use not less than a No. 8 for mechanical reasons. A much smaller wire could be used for inside work. Chas. W. Stone.

If outside wires are No. 2 in Edison three-wire system, the neutral should be one-half the size of the outside wires, or No. 5 B. & S. gauge. The neutral wire in alternating-current system is usually made of the same cross-section. F. D. Sampson.

P 28. What is the best method of carrying low-tension, three-wire distribution mains through trees that are too large to admit of carrying the wires over them on poles; and has any system of cabling such wires been successfully used?

Wires can be cabled, but it is too expensive. In nearly every case owners of property will allow trimming of trees if this is done judiciously; however, unless the limbs are very large it is hardly necessary to trim them, as the loss is very slight, except in extremely wet weather. A. W. ZAHM.

If trees are not higher than 50 feet they can be gone over; if higher than this, go below branches on extended arms.

BEACON LIGHT CO.

Standard three-conductor lead-covered cable would be hard to improve upon. RALPH R. LAXTON.

P 29. What is the practicability of the following plan? To facilitate the extension of five-wire service lines and avoid a multiplicity of wires, it is suggested that the five wires be encased in a light-weight weatherproof case. Give method of fastening to cross-arms and building.

Cables with standard cable hangers should answer.

RALPH R. LAXTON.

P 30. What can be done to divert public sentiment against the unsightliness of overhead lines?

Build good looking pole lines; when poles are set in streets avoid locating them in front of people's houses, in so far as possible. Paint poles a dark green, to conform with foliage.

T. H. T. & L. CO.

This is an open question, which many of us would be glad to have solved. Put up good construction and keep it in good shape. Place your poles on property lines—never in front of residences. Don't let your wires burn trees. Don't allow a live wire to remain in the street long. Paint the butt of your pole green for five feet above ground, and the rest white; also paint cross-arms white. This is contrary to my present practice, and contrary to the opinion of most municipal officers who advocate green until they are shown differently. Your poles should be the color of fences, out-houses, flag-poles, *et cætera,* which are in most cases of a light color. I have used both colors and think a white pole has more to do with keeping down kicks against pole lines than any other one thing, as this color does not make the pole so objectionable. We are using green poles entirely, owing to the terms of our franchise. I should, however, recommend a green butt and white top, as above described. E. C. DEAL.

First, install all lines in alleys, where possible, and in cases where no alleys are available, in the rear of the property, thus making the lines as inconspicuous as possible. Use neat and substantial style of construction. Step and paint the poles. A pole can be made very unsightly by being spur-marked. Comply with requests and complaints, such as changing slightly location of wires and poles, wherever possible. PAUL F. WILLIAMS.

In telephone work, except for long-distance purposes, it is standard practice to use a low pole-line and carry all the circuits in cable, tapping out pairs at the poles from which the service loops run. Of course, cable construction is not desirable for overhead power circuits. Our experience has been that when lines carrying a small number of open wire circuits are carefully and substantially built and properly maintained, there is practically no sentiment against them on the part of the public.

F. S. FRANCIS.

Eliminate unsightliness. This can generally be done by attending to the three following conditions: first, set poles plumb and in line; second, have cross-arms all horizontal and squared; third, keep lines taut. A. T. BEAUREGARD.

Paint poles an obscure color, such as a dark gray or a foliage green. Keep lines in good shape and set poles on the property line wherever possible. Have poles of sufficient height to avoid having the wires in the line of vision at all times. A. W. ZAHM.

Build and maintain the pole lines in the best possible manner. DUGALD C. JACKSON.

Put up nice straight poles, paint them and pull your lines taut. Pole lines well put up are, after all, no more dangerous than conduit systems or underground wires. This has been demonstrated in the operation of high-tension lines, both overhead and underground. Of course, this does not apply in large cities where overhead wires are impossible. F. D. SAMPSON.

The unsightliness and even the dangers of overhead construction are too obvious to be controverted by any attempt to "divert" public sentiment. The sentiment is a healthy one. An educated public will always be an æsthetic public, and it is to the educated public that the electrical profession and industries must look for support. The most we can ask from the public is forebearance until we can arrive at a better solution of the transmission problem. The policy of "diversion" will not do. It is Darwinianism reversed, as typified by a distant view of the ascending or descending "climber" with his hand lines trailing from his belt. RALPH R. LAXTON.

P 31. What results have been attained in the matter of treating poles to prevent decay at the top of the ground?

Paint the butt of pole, to a point at least one foot above the ground, with creosote or coal tar. A. W. ZAHM.

We are experimenting in some parts of the country, particularly in the South, with creosoted butts. These experiments are of recent date and no definite figures can be given at this time.

F. S. FRANCIS.

Charring the butts of poles about one inch deep has proven very successful in some places. It costs less than the majority of decay-preventive remedies. F. D. SAMPSON.

We are using carbolineum as a treatment for butts of poles, and think it has considerable advantage over no treatment.

F. A. JOHNSON.

Butts should be tarred or painted with asphaltum.

C. K. N., N. Y. Ed. Co.

P 32. Are single-petticoat glass insulators good for 2200 volts?

A double-petticoat glass insulator should be used, even on low tension. A. W. Zahm.

Single-petticoat glass insulators were once used a great deal on 2200-volt systems, although I do not consider it good practice. I would recommend the deep-groove, double-petticoat glass insulator for this class of work. E. C. Deal.

Depends largely upon the climate. Would advise double-petticoat. A. Peters.

F. D. Sampson.

On a series system they would work; on a multiple system the leakage in wet weather would be very heavy.

Beacon Light Co.

No. H. D. Larrabee.

P 33. Are ordinary deep-groove double-petticoat glass insulators all right for 6600-volt alternating-current circuits?

We have had 6600 volts on a line six miles long for the past year, using ordinary deep-groove, double-petticoat glass insulators, and have experienced no trouble on that score.

W. P. Schwabe.

Have had ordinary deep-groove, double-petticoat glass insulators in use for five years on a 12-mile, 6600-volt, three-phase transmission line, with no trouble whatever due to insulators.

P. H. Korst.

We have about 5000 double-petticoat, deep-groove, glass insulators in service on our 6600-volt transmission lines and have experienced no trouble whatever up to the present time. The wire used is ordinary triple-braid, weatherproof No. 1 copper. We have recently adopted the triple-petticoat glass for this class of work and have experienced no trouble with them. I can not, however, say that the triple-petticoat has any advantage over the double-petticoat for this class of work, inasmuch as the triple-petticoat is more frail and liable to breakage. E. C. DEAL.

No; although they would stand in fine weather. Wood pins and arms being used. A. PETERS.

Sixty-six hundred volts is too high a potential for ordinary double-petticoat glass insulators. Try triple-petticoat glass or porcelain, preferably the latter. F. D. SAMPSON.

Sixty-six hundred volts requires a special insulator, preferably a double-petticoat porcelain insulator, especially made for this purpose. A. W. ZAHM.

Some few of them may work satisfactorily, and at the same time answer the purpose as lightning arresters.

BEACON LIGHT CO.

P 34. (a) Is there any method for making joints with large sizes of aluminum cables which is not prohibitive owing to the size of the finished joint, the possibility of oxidization when used bare, or similar causes? (b) Is there any practical method for making a soldered joint, and, if so, how?

(a) Compression joints on aluminum cables of 00 copper equivalents are entirely successful and satisfactory, also upon sizes of smaller cross-section. No oxidization is possible with this form of joint.

(b) There is a soldering flux on the market, but it is of doubtful value, the fusing temperature of aluminum being so low that in soldering the joint you are likely to injure the cables.

F. D. SAMPSON.

Why not use a Bossert solderless joint? A. PETERS.

P 35. Considering costs and difficulty of making satisfactory joints, does aluminum show any advantages over copper for either high-tension direct-current transmission to substations or low-tension direct-current distribution when the company's entire system is underground?

P 36. Considering costs and difficulty of making satisfactory joints, does aluminum show any decided advantages over copper for high-tension long-distance transmission work?

Taking for granted that sufficiently high potentials are to be used to limit your cross-section to a copper equivalent of No. 00 for a three-phase transmission, the most decided advantage is that of the decreased weight carried upon your poles or towers. Another feature is that aluminum can be strung for less money per mile from a labor standpoint. As to the cost of aluminum, this I believe is somewhat problematical when purchased in the open market. F. D. SAMPSON.

P 37. In order to increase the tensile strength of copper wire it is proposed to use a small core of steel. What effect will the presence of this steel have when the wire is used in transmitting alternating current?

This would be purely a question of test. Mechanically, it does not sound good; electrically, inductive currents might be set up to increase inductive resistance of circuit. The tensile strength of copper is usually sufficient in most overhead work where the energy of the circuit transmitted is calculated.

F. D. SAMPSON.

The small steel core referred to is not likely to interfere with the successful use of the wires for short-distance alternating-current distribution when ordinary frequencies are used, but former experience with such wires shows that they do not afford the advantages in physical strength which might be expected of them and that they deteriorate rapidly. DUGALD C. JACKSON.

No effect whatever. H. D. LARRABEE.

P 38. On pole lines carrying 2200-volt alternating current, which is the better policy in connection with safety to linemen repairing or connecting lines or apparatus—to shut down the 2200-volt line at station or branch, or to leave all lines alive and have it so understood?

Leave lines alive and have it so understood, because linemen will work barehanded on wires supposed to be dead, and if these should be crossed with a live line, or otherwise receive current, the man handling same will get hurt, which has often happened. W. P. SCHWABE.

Leave all lines alive at the station and have it so understood, but allow the line foreman to disconnect a branch line when extensive repairs are to be made, he only to put the same in service again. A. T. BEAUREGARD.

All linemen should be taught to consider all wires as alive. In dry weather, with wooden poles and proper spacing of wires on pins (say, 18 inches apart), taps can safely be made on 2200-volt circuits; in wet weather, rubber gloves can be used. However, insist on making it a rule for linemen to finish one joint at a time, solder and tape, be it a single-phase or a three-phase tap. You can not afford to cut off a power-service feeder every time a connection is made. F. D. SAMPSON.

It is not necessary to cut 2200-volt lines dead to enable linemen to work upon them. A good lineman will not want the current off and a poor lineman should not be allowed to work upon your lines whether they are dead or alive. E. C. DEAL.

It is needless to shut down for 2200 volts. Keep your lines alive at all times, have your men properly equipped with safety belts and rubber gloves and advise them fully, giving them printed directions, as to the precautions necessary. A. W. ZAHM.

Leave all lines alive and have it so understood. Furnish best quality rubber gloves and safety belts. Have foreman or assistant superintendent inspect gloves and safety belts weekly. You can not expect your consumers of power to be satisfied with the service if you allow your men to cut off the service at will, as they will do if not watched, sometimes for the most trivial repairs. Uninterrupted electric service should be paramount in any public-service corporation. F. M. Vander Voort.

Leave them alive, and have it so understood.
H. D. Larrabee.

I prefer cutting off current, if possible.
Ralph R. Laxton.

P 39. What are the usual precautions taken to protect arc trimmers in case 2200-volt, 60-cycle circuits come in contact with the series arc circuits?

Ground arc circuit on both legs at station and at testing-room. Herbert McNulta.

Each lamp should have a double-pole cut-out, to be thrown when working on the lamp. It is good practice for a trimmer to carry a board, properly insulated, to stand on when trimming if the lamps lower to the street. W. W. Titzell.

(Practically concurrent opinions expressed by F. D. Sampson, A. W. Zahm, H. D. Larrabee, E. C. Deal, Ralph R. Laxton.)

P 40. (a) What is the best method of locating grounds on series alternating-current arc circuits operating from constant-current transformers? (b) Can it be done successfully when circuit is in operation?

A static ground detector should be left in circuit at all times. The ground can be located and removed while circuit is in operation. A. W. Zahm.

(a) Use the same method that you use on a direct-current, constant-current arc circuit. There are several methods in practice.

(b) Grounds can be successfully located when circuit is in operation. I do not believe it is done in many places.

E. C. DEAL.

Prefer testing with heavy magneto with current off. There are usually a number of points from which it is possible to ring two ways from a lamp, thus locating grounds within small territory.

RALPH R. LAXTON.

P 41. In a town where there are alternating-current wires, 2200-volt, single-phase; Edison three-wire, 110-220-volt direct-current and telephone wires on the same poles, is it good policy to ground the neutral of the three-wire direct-current line? Also one of the secondaries of the two-wire alternating-current distribution?

The neutral wire of an Edison three-wire system should be grounded at all times, but I should deem it bad practice to ground one of the secondaries of the two-wire alternating-current distribution. Install transformers of sufficient size to operate one three-wire circuit, in which case the neutral should be properly grounded.

A. W. ZAHM.

I consider it good practice to ground the neutral of the three-wire direct-current line, also one of the secondaries of the two-wire alternating-current distribution system, regardless of other wires carried on the same poles. But the entire construction should be kept at all times in good shape. This, of course, should be done whether your neutral and secondaries are grounded or not.

E. C. DEAL.

The grounding of Edison neutral is generally required by underwriters, and they approve of grounding one side of alternating-current secondary where it is impracticable to run three-wire alternating-current secondary system.

RALPH R. LAXTON.

Under the conditions named it is eminently desirable, according to the writer's opinion, to ground as stated.

WM. B. JACKSON.

Yes; for safety of persons. W. H. Wolvekamp.
A. Peters.

P 42. Can a high-potential, direct-current, long-distance transmission system, say from 1000 to 20,000 volts, be satisfactorily installed with a grounded negative for one side of the circuit? If so, what would be the method of generating and how would this pressure be brought to a working pressure along the line?

Have never heard of any such voltage being used with direct current. It would certainly be very dangerous to ground one side of such a system could it be put into use. Direct-current voltage of this magnitude could be generated by putting in series a sufficient number of generators of the proper voltage. In order to get pressure back to a working voltage, I would suggest having motor-generator sets, the same as are used in obtaining a derived neutral or balancing set on two to three-wire transmission. M. C. Turpin.

No. The ground return would generally be worthless from an operative standpoint and a source of great danger. At the higher voltage mentioned no insulation would be safe. The generating apparatus for this voltage, direct current, would necessarily be enormously expensive and limited in current capacity; and transformation to working voltage for motors of small size is almost impracticable.

You will find both questions exhaustively treated by Dr. Louis Bell—ground return, in his book on *Electric Distribution for Railways;* the other in the chapter on *Transmission by Continuous Currents in Electric Power Transmission.*

Ralph R. Laxton.

P 43. What is best position of ground wire with respect to the three-line wires, i. e., on side, above, or in centre of triangle?

The best position of ground wire is on top of pole above centre of triangle; with a properly-spaced triangle the ground wire is farthest off from line to ground when located at top of pole, and in the best position to collect high-potential discharges, especially if connected to the earth at very frequent intervals. With this arrangement no poles have thus far been split on our transmission lines by lightning. F. D. SAMPSON.

P 44. Where ground wires run down the side of the pole from transformers, lightning arresters, etc., what is the best way to protect the people from getting a shock on them in case wire should happen to be broken off just above the ground?

To prevent ground wire breaking off just above the ground use insulated wire from ground plate to about seven feet above surface of earth and incased in galvanized-iron pipe. Have regular inspection. We have found this to work very satisfactorily.
E. A. VAUGHAN.

Have ground wire of good-grade rubber insulation, run it on insulators down pole to within 12 feet of the sidewalk, then have wire enter a pipe; solder it good and solid to both ends of the pipe. Pipe should also be grounded to a buried copper plate. To prevent injury to pipe, groove pole out, making a recess to receive pipe, making it flush with pole.
CLAYTON F. GEIGER.

Have pipe ten feet long, eight feet above ground and two feet below. Have cap on each end of pipe, and where the wire goes through the caps, solder the wire to caps thoroughly.
H. E. RYDER.

A method that has proved very satisfactory has been to enclose the ground wire in an iron pipe leading from the ground plate to a point higher than can be reached by the people.
WM. B. JACKSON.

Run ground wire through three-quarter-inch pipe eight to ten feet long, lower end of pipe driven into ground, wire bare in pipe. HERBERT MCNULTA.

Good construction and mechanical protection of the wire. A long iron pipe, however, is not to be recommended.

W. H. Wolvekamp.

A moulding properly painted inside and out with some wood preservative has been quite successful. A gas pipe driven into earth sufficiently to insure good connection has also been used to advantage. Lightning-arrester grounds connected with city pole distributions should have single-pole switches or fuses of low resistance, so as to disconnect ground wires temporarily for trouble with arresters and inspection. F. D. Sampson.

Use a two-inch half-round wooden moulding over the ground wire from the ground up to the cross-arm. Fasten moulding to the pole by means of long staples, which should just fit over the moulding and should be driven home. Space staples three feet apart. Make them of quarter-inch round iron and drive them not less than three inches into the pole. E. C. Deal.

Ground wire should be covered with moulding from ground to cross-arms to prevent accidental contact by lineman or passer-by. F. M. Vander Voort.

The ground wire should be protected on the pole by a strip of half-round wooden moulding, extending from the highest point of attachment to the pole to not less than six inches below the surface of the ground. A. T. Beauregard.

(Practically concurrent opinions expressed by Ralph R. Laxton, Paul F. Williams, Samuel Kahn, H. B. Gear, W. P. Schwabe.)

P 45. What effect has a grounded line in close proximity and parallel to a long high-tension transmission line at times of high-voltage surges?

Since the requisite conditions for creating capacity are large surfaces and thin dielectric, and since in transmission lines the condenser effect takes place, not only between the individual wires themselves, but also between them and the ground, it follows that the closer a line is to the ground, the thinner will be the cross-section of air space (corresponding to the condenser dielectric) between them, and the greater will be their capacity. It seems to me that a ground wire carried close and parallel to the lines will have a similar effect. Also, when a breaker lets go on the peak of an abnormal current wave the energy bound up in the field surrounding the lines discharges itself in violent oscillations, or surges through the resistance and between the inductance and capacity of the line, so that to take up this high-frequency high-voltage e. m. f. and prevent damage to insulation we require the ratio $\frac{\text{capacity}}{\text{inductance}}$ to be as near unity as possible, and since in aerial ines the capacity is always much less than the inductance, increasng the capacity will bring our ratio nearer unity and thus lessen he liability to puncture during surges. It can also be mathematiclly shown that the presence of a closed circuit in close proximity o another carrying an alternating flux will tend to increase the quivalent resistance and reduce the equivalent inductance of this atter so that the increased equivalent resistance due to the ground ircuit should also help to take up more of the surge and lower he risk of puncturing.

It must be remembered, however, that great caution must be xercised (especially on lines having high fundamental frequenies and low ohmic resistance) in increasing the capacity that a ability to resonance or syntony does not accompany such increase.

JOHN AUCHENCLOSS.

The grounded line would at times suffer from disturbances imilar to those from lightning, only less severe.

RALPH R. LAXTON.

P 46. Has any serious trouble developed due to static disharge where high-tension cables leave the overhead lines to go nto conduits? If so, what is usually done to overcome the diffiulty?

We have two 6000-volt, two-phase, 60-cycle transmission nes, one five miles long and the other seven. Where the overead lines meet the underground cables we simply make a joint carefully taped and painted. These lines have been in operatio about six years and have never caused any trouble at the poi above mentioned. United Elec. Lt. Co.

It is the place for lightning arresters. W. H. Wolvekamp.

P 47. What is the best practice in caring for lightnin arresters and keeping records of lightning storms and effects?

If arresters are properly located and are of a good design will only be necessary to have them inspected once a year. Th should be done in the spring, just before the storm season com on. Have the most important arresters, such as station and jun tion-pole arresters, inspected after each storm. I do not consid records of lightning storms of any value. I think your tran former history, if you have one, will tell the tale. E. C. Deal.

Have your lightning arresters tested after each lightning storm.
A. W. Zahm.
W. W. Titzell.

P 48. How many lightning arresters should be used per mile on an alternating-current circuit of 2200 volts?

This depends upon conditions. Always place the arresters at the highest point in the line, have them properly grounded and have not less than two per mile. A. W. Zahm.

Have good installation of arresters on each feeder leaving the power-house and a set on a pole one span from each transformer connected; that is all that is necessary. If you have a five-mile run of 2200-volt line between which points you have no apparatus connected, it is only necessary to install arresters on each end of the line. E. C. Deal.

One arrester per wire per mile will give satisfactory results if properly grounded and cared for. Particular attention should be given to exposed points and to the ends of long lines.
F. M. Vander Voort.

Some districts are much more open to atmospheric disturbances than others, consequently a very liberal installation of arresters is absolutely necessary. BEACON LIGHT CO.

Theoretically, the more the better. For the number, the climate should be taken into consideration. For the distribution, the elevation above water level should not entirely be lost sight of.
W. H. WOLVEKAMP.

If the line feeds a net work of secondaries, an arrester should be placed at the station and one at every transformer.
SAMUEL KAHN.

I prefer grouping arresters near station on purely transmission lines having no branches. Am using, on a 12,000-foot, 2300-volt line connecting steam and water-power plants, a bank of arresters in each station and another bank on nearest pole to each station, and expect to put choke coils between last arresters and switchboard at each end of line. On distribution lines, the arrangement of arresters should be such as to protect each branch and its transformers. Probably half-mile between banks of arresters is not too much in average practice, but this depends upon the number of transformers, *et cætera,* to be protected.
RALPH R. LAXTON.

P 49. What make of lightning arrester would be the best on construction carrying 1000 volts? How many are necessary per mile, and what method would be considered best to properly install ground wire from same? Formation of soil is stony.

The General Electric Company and the Westinghouse Company both make satisfactory lightning arresters for this purpose. Have not less than two per mile. Where formation of soil is stony have an extra large ground plate made in the following manner: Dig a trench at least two feet wide and six feet long to a depth of not less than five feet. Fill the bottom of hole with fine-crushed coke. Place ground plate, consisting of a sheet of copper about eighteen inches wide and six feet long, on top of this coke. Add coke to the depth of at least six inches and tamp thoroughly. The addition of a quantity of salt will maintain moisture and add to the value of the ground plate. The ground wire should be thoroughly attached to the plate throughout its entire length. A. W. Zahm.

There are several makes of good lightning arresters for 1000-volt lines. I have had experience with those of the General Electric and the Westinghouse Company and find them very good. As to the number per mile, see answer to P 48. Attach ground wire if possible to a near-by water pipe or trolley rail. If this can not be done attach ground wire to a copper plate not less than eighteen inches square, which should be buried sufficiently deep to insure its being surrounded by moist soil at all times. Better still, bury it in a bed of fine and well-tamped coke. Another method that I consider very good in connection with new work, is to put down a galvanized-iron pipe from four to six feet in the bottom of post hole before throwing in the pole. Attach ground wire to the galvanized-iron pipe and coil several feet of the wire in the bottom of the hole. Chuck pole in on top of the pipe and coil of wire. Then carry wire up the pole to the arrester. E. C. Deal.

(a) See P 48.

Follow the method of Underwriters' National Association rules. Arrester is only fit to use when the ground wire can find permanent moist ground not too far away, or good pipe connection. W. H. Wolvekamp.

Westinghouse-Wurts non-arcing and General Electric carbon-type are good. See answer to P 48. Groundplate 3x6 feet, copper-riveted and soldered to No. 0 wire and buried in coke or charcoal at level of permanently moist earth. This is for station protection. For line work, solder No. 4 or No. 6 wire to brass plug and screw this into a piece of galvanized pipe driven down to moist earth. Ralph R. Laxton.

P 50. Give good plan for grounding lightning arresters.

Our experience in connection with the grounding of lightning arresters has shown that the grounding of copper plates in coke, so often recommended, is not satisfactory. We have dug up copper plates that had been one year in a bed of coke in damp ground that were very badly corroded. We have, therefore, abandoned the use of coke. Now drive 1.25-inch galvanized iron pipe as deeply into the ground as possible, placing beside it a copper plate 36 inches long, planted just deep enough that the top will be exposed above the surface. We have observed that, in nearly all lightning storms, the shower of rain which precedes the severe lightning will wet the surface and thereby give us a ground of some value at the top of the plate, should the earth be very dry beneath the surface.

EDISON ILL'G CO. OF WEST CHESTER.

The standard bolted made-up junction devices, in seasons of heavy load, were depended upon to handle as high as 700 amperes each. Contact surface too small, nuts becoming loose and fuses shearing off on account of wind strains on joints, almost annually disrupted service at critical time. The equipment was replaced two years ago by substantial soldered lugs mounted on fibre centres bolted securely. Have handled two seasons' peak load without one interruption. D. L. OTT.

Q—UNDERGROUND LINES

Q 1. What is the best underground construction for one or two circuits in a village where company is required to run lines underground in a few places?

Would suggest creosoted pump-log conduit. It is used largely by the eastern telephone companies and its life is satisfactory. F. M. VANDER VOORT.

There is nothing better than the standard vitrified-conduit construction with manholes in which are pulled the regulation cables. L. L. ELDEN.

Where it is necessary to place circuits underground on any of the principal streets of a village it would be advisable to construct conduit lines composed of vitrified-clay tile with manholes at street intersections large enough to accommodate transformers, in case it is desired, at any future time, to install alternating system underground. In case alternating circuits are to be put in for private lighting, small manholes can be built at intervals of 500 feet, where laterals may branch off to reach customers on both sides of the street. Service taps can then be made in these manholes and carried into the customer's premises.

The number of ducts to be used should be considerably more than the present requirements, to provide for future increase of the number of circuits and the system, as in most cases additional circuits could be carried through the underground portion of the system along the same route and then come out overhead at places where the city officials would permit of overhead construction.

Where it is necessary to cross streets on which lines are required to be placed underground, iron pipe should be laid across the street, having risers on each end going to the top of the pole; it would then be possible to pull cable across street-crossing from top of pole to top of pole and avoid the expense of putting in manholes. B. E. STROHM.

Q 2. Describe method of building waterproof manholes?

In order to build a water-proof manhole, it is first necessary to make the excavation large enough for a man to work back of the wall when built. If the manhole is to be of brickwork, the brick should be laid with flush joints and no space left without mortar. About one-half inch of mortar should be plastered on the outside of brick wall.

There are several preparations, said to be watertight, which may be applied also to the back of the walls and the bottom inside of manholes. The roof should be well plastered.

Several courses of tar paper and gravel, the same as used on gravel roofs, may be used to good advantage in keeping water out of manholes.

Of course water-proof manholes are too expensive to be practical for ordinary construction, except in cases where absolutely necessary. GEO. B. SPRINGER.

It is almost impossible to build an absolutely water-proof manhole. Our manholes are built with concrete floor and side walls, reinforced concrete of iron and brick coverings, with iron openings and cover. TOLEDO RAILWAYS AND LT. CO.

Q 3. What means do you employ to protect your cables in manholes from injury due to burnouts in adjacent cables?

Asbestos tape securely wrapped around the cables furnishes a very satisfactory protection from ordinary burnouts. Where large quantities of current are being transmitted it is advisable to install suitable shelves or partitions to still further protect the cables from each other. L. L. ELDEN.

In place of using brackets, as was formerly the practice, light sheet-iron shelves are put around the manholes and the cable covered by means of split vitrified-tile. The shelf is put in to take the weight of the tile off the cable, and one shelf is sufficient on each side of the hole to take care of a dozen or more cables, as the tile, when put on, is cemented around the joints and when the cement has set the tile will support its own weight. In this way each circuit or cable is as safe from damage or burnout from adjacent cables as it is in a straight conduit line.

When it is necessary to take a tap off any cable in the manhole it is an easy matter to knock this tile off, make the connection and afterward place tile over the joint. B. E. STROHM.

We wrap each cable in manholes with asbestos tape.
J. J. GAFFNEY.

Q 4. What devices, if any, are installed to relieve abnormal rises of potential in large cable installation?

Install General Electric non-arcing lightning arresters as line dischargers in a similar manner as we put them on tub-transformer circuits to protect from the effects of resonance.
F. M. VANDER VOORT.

This company has as yet found no necessity to install any devices to relieve rises of potential in the cable system other than standard lightning arresters on the outlets of underground cables where they are attached to the overhead lines for the purposes of lightning protection. L. L. Elden.

No devices are employed in connection with our high-tension transmission system for the purpose of relieving abnormal rise of potential. Ernest F. Smith.

Static dischargers. Ralph R. Laxton.

Q 5. Which is the best practice, in running underground leads from 2300-volt, three-phase generators to switchboard and from switchboard to step-up transformers—to use three-conductor lead-covered cables or three single-conductor lead-covered cables, and why?

Single-conductor cables are preferred for this use, and, if possible, cables without lead covering should be used, it being preferable to provide a cable having extra insulation suitably waterproofed if the conditions permit its use. L. L. Elden.

Three-conductor lead-covered cables, as single-conductor lead-covered cables induce current in lead sheath, which causes a drop in voltage on line and heating of the lead sheath.
W. T. Oviatt.

Use single conductors; less liability of trouble and greater flexibility without any disadvantage except greater first cost.
H. A. Strauss.

The use of three-conductor lead-covered cables is believed to be in accordance with best practice. Ernest F. Smith.

It depends upon length and facility of run. If lead cover must be used and circular milage of cable is not too great, use three-conductor. Prefer cambric single-conductor to either, wherever possible to use it. B. Jamieson.

In regard to running single or multiple-conductor leads from terminals of 2300-volt generator to switchboard, and from switchboard to step-up transformers, in large installations, it is generally conceded the best practice to operate with single conductor rather than three-wire cables, on account of less chance of damage to any pair of conductors. For local reasons, however, the reverse may be the case. THE PHILADELPHIA ELECTRIC CO.

I prefer single-conductor cables in separate vitrified conduits, because with this arrangement it is practically impossible for lightning or static discharge to cause a short-circuit by puncturing the insulation. RALPH R. LAXTON.

Q 6. How many times were your cables out of service in 1905 for repairs? Give character of insulation and dimensions of cable, size of copper, thickness of insulation, thickness of lead sheath, over-all diameter and approximate length.

Q 7. What member companies are using lead-covered cables for transmitting 25-cycle current underground at 15,000 volts or over?

Q 8. What member companies are using lead-covered cable for transmitting 60-cycle current underground at 10,000 volts or over?

Q 9. If any of the companies are operating combined underground and overhead circuits of 10,000 or 15,000 volts or over, do they experience more trouble on these than with circuits exclusively underground, and what special protective devices do they install for this work?

In the case of transmission lines carrying 10,000 volts or over, run partly overhead and partly underground. Lightning arresters and line dischargers, located in suitable houses, should be provided in every case where change from overhead to underground occurs. DUDLEY FARRAND.

Q 10. Does your company supply service switch and cutout on underground distribution? Do you find this practice advantageous?

All service switches and cutouts are supplied by this company and this practice is considered very advantageous to the company in the reduction of liability that is likely to arise from the promiscuous installation of various types of switches and cutouts by incompetent persons. L. L. Elden.

The Milwaukee Electric Railway and Light Company furnishes the service cutout for both underground and overhead services, using for this purpose the "Noark" type of iron box with "lobster-claws" in cover. These give it the combined function of switch and cutout with advantages of less space than for two pieces of apparatus, offers less temptation to theft of current than an open type, can be sealed when occasion requires and uniformity thus secured enables trouble-man to conveniently carry a supply of fuses to fit any box. G. R. Radley.

We do not supply service switch and cutout on underground distribution. We do not believe we should. W. E. H.

Q 11. What should be the cross section of each strand in a copper cable consisting of 61 strands, in order that the resistance of such a cable shall exactly equal the resistance of a solid copper bar having a cross section of 500,000 circular mils; it being necessary, of course, that the 61 conductors be twisted together to form the cable, each strand thus following a long spiral course?

With copper of 100 per cent conductivity, Matthiessen's metergram standard, it would require 61 wires of 8197 circular mils each to form a strand having conductivity equal to that of 500,000 circular mils, solid conductor. This ignores the correction due to the short-circuiting of the wires of the strand upon one another and also the correction due to the increased resistance of the wires in the outer layer of strand (resulting from their increased lengths as compared with the length of strand itself), which two corrections in commercial strand practically

ffset one another, the net result being that in a well-made
ompact strand, formed as described, the resistance should be
ightly less, if anything, than that of a solid conductor. The
eight of such a strand (assuming that the average lay is normal
nd the average increased length of component wires is there-
ore 1.0146 times the length of finished strand) would be 1535.3
ounds per 1000 feet. An absolute determination would require
knowledge of the exact length of the lay used in operation,
e degree of compactness of the strand, and the reduction in
onductivity of the component wires used, due to handling (and
onsequent hardening) in the stranding process, all of which
ary with conditions and practice. P. H. W. SMITH.

Circular milage of the individual strand of a 61-strand cable
at would give the same copper resistance as a 500,000-cm solid
od, is 8208. Actual measurements on cables were made
hich show that where the individual wires before cabling show
onductivity of from 99 to 100 per cent, conductivity of the cable
uns from 98 to 99 per cent. Conductivity will sometimes show
omewhat higher than this when the cable is first stranded and
here the individual wires of the cable are bright and untar-
ished. Since, however, the cable contains air it is only a ques-
on of time when the surfaces of the individual wires become
ore or less tarnished, allowing the larger portion of the current
ansmitted to follow the spiral path. WALLACE S. CLARK.

Sixty-one wires should be employed of 8196.7213 circular
ils each to equal the resistance of a 500,000-cm solid wire. 1000
eet of cable made to above wires will equal, *in resistance only,*
000 feet of a 500,000-cm solid, but will weigh more and be of
reater diameter. The excess in weight is due to cabling and
ot in the cross section of actual amount of copper in the cable.
H. T. FIELD.

In experiments I have made, I found that the decrease of con-
uctivity in the strand was almost equal to the twist in the wires.
n an ordinary strand, for example, the twist in the wires may
e taken at 2.5 per cent. According to the ordinary definitions
500,000-cm cable should be made of 61 wires, each having

such a diameter that when laid out straight their combined cross section would equal 500,000 circular mils. When these wires are twisted up, the cross section is increased by the amount of the twist, say 2.5 per cent. If my theory is correct, that the electric current follows the individual wires, then the resistance of such a cable would be about 2.5 per cent more than the resistance of a solid wire. In order to make a 500,000-cm strand have the same resistance that a 500,000-cm solid wire should have, I should say that the section of the strand should be increased by about 2.5 per cent, making 512,500 circular mils. 500,000-cm, 1,000,000-cm, etc., are as standard sizes as wire gauges. I believe the question should be asked as to the resistance of these standard strands. The resistance of these strands, of course, is easily calculated on the basis of their being of solid copper of 100-per cent conductivity. Increasing their resistance about 2.5 per cent would, in my estimation, give the proper results for an ordinary strand. There is no definite answer to the question. In either form it depends on the voltage of the current used. In testing, a small, mild current might have less tendency to go from one wire to the other than a heavy current of greater potential. It depends on the length of the lay or the distance along the strand, corresponding to one complete spiral of a wire. It depends on whether the wires are perfectly clean or are coated with oil; and if an insulated cable, it depends on the extent to which the insulation penetrates the strand. If it is a question of specification, I am always in favor of the following form for a strand. Specifications for 500,000-cm strand:

The strand shall be composed of 61 wires, whose average diameter shall be not less than .0905 inch. The conductivity of each wire shall not be less than 99 per cent Matthiessen's standard as recommended by the Standard Wiring Table Committee and reported to the American Institute of Electrical Engineers, January 17, 1893. F. J. NEWBURY.

The resistance of stranded cables is calculated for the solid wire of the same circular milage. It is true that each strand forms a long spiral course, but it is furthermore true that the current is not forced to take this spiral course because of the surfaces in contact between the several strands.

L. D. NORDSTRUM.

We have never made any tests to determine this point. The commercial practice is to consider the resistance of the cable equivalent to the equivalent size in circular mils or solid wire.

THE F. BISSELL CO.

Assuming that the spiraling of the wire took five per cent more wire than if the wires were laid straight, the cross section of each strand in a copper cable consisting of 61 strands, which has the same resistance as a solid copper bar with a cross section of 500,000 circular mils, is:

$$\frac{\sqrt{\frac{500{,}000}{1.05\text{x}61}}}{1000} = .0883 \text{ inches}$$

I. W. SMITH.

Approximately 8200 circular mils; while the length of each strand is greater than a straight wire, the wires are twisted together and practically amount to the same as a solid rod.

A. PETERS.

Q 12. What is the best form of primary cutout box to be used in connection with 2000-volt transformers installed in manholes?

We use single-pole "Noark" boxes for protecting transformers on 2200-volts in manholes. UNITED ELEC. LT. CO.

Q 13. Is it practical to operate large underground 60-cycle alternating-current secondary systems using single-conductor, lead-covered cables; if not, give reasons?

Q 14. Are potheads desirable on terminals of all alternating-current underground cables 1000-volt and over—one, two or three-conductors?

Potheads are desirable on alternating-current cables of 1000 volts and over, at terminal poles. It is preferable to use multiple-conductor cable to the manhole at the base of the cable pole and there splice on to single-conductor cable, which is taken in iron conduit up the pole. These single-conductor cables should be equipped with potheads. The opposite polarities are thus easily kept apart on the pole and a cumbersome multiple-conductor pothead is avoided. A new form of pothead made of porcelain, having a weatherproof cap and arranged with metal parts that can be pulled apart, has been found very satisfactory and less expensive than lead potheads. The pothead and disconnecting switch are combined in one device which is safe to handle and easily installed. H. B. Gear.

We do not think potheads are necessary. We make an ordinary joint, well taped and painted, on both 2200-volt, 60-cycle circuits and series arc circuits whose voltage is 8000 and over. Have never had any trouble, and the appearance of the lines is much better than where potheads are used.

United Elec. Lt. Co.

Q 15. What is the best method of holding lead-covered cables installed in fire-clay ducts to prevent them slipping?

Q 16. What is the maximum grade on which lead-covered cables can be installed in fire-clay ducts without special provision being made to prevent them slipping down?

Q 17. In a system of Edison three-wire underground cable mains installed in conjunction with a system of 500-volt underground cable mains, what is the best method of taking off services from each system?

Q 18. Give status of high-tension underground transmission as to highest permissible working voltage—not on a few individual lines, but for large system—and the actual commercial and operating advantages thus far experienced.

Philadelphia Rapid Transit Company is using very successfully 13,000 volts underground distribution. Volamfwat.

Q 19. It has been an acknowledged fact that on the Edison nderground tube system the underground troubles come on, pecially in the night, at low-load. Do the lead-covered cables ɔw used have the same characteristics?

In five years' operation of underground system I found that e majority of faults developed during the night and usually after e peak of the load. This is for lead-covered cables, including ngle, duplex and triple-conductor. F. M. VANDER VOORT.

R—TRANSFORMERS

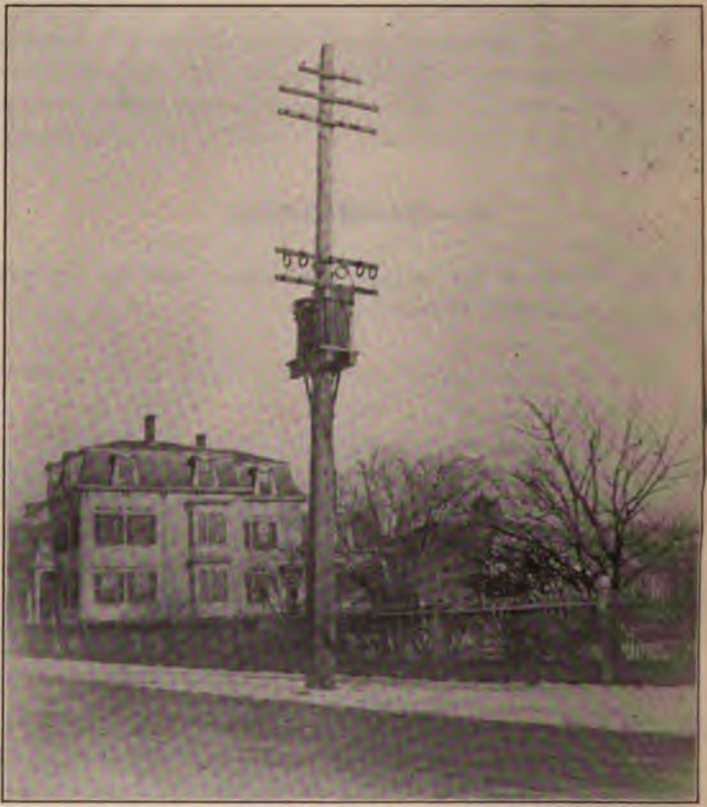
R 1. What is the largest transformer you use on poles? ive detail of method of hanging.

Thirty-kilowatt transformer is the largest we have on our oles. The method used in hanging same is as follows:

See that the pole is physically able to carry the transformer, ıen bolt a pin cross-arm to the pole, 20 feet from the ground, nd another arm three and one-half feet above the first arm. /e then take a pair of blocks and falls and fasten to the top f the pole and raise the transformer by the aid of a team of orses until it reaches the top of the cross-arm, and before emoving the block and fall we place a five-eighth-inch eye-bolt n the pole four feet above the top cross-arm and use a Brooklyn rain insulator, and some seven-strand iron guy-wire to guy the ansformer to the eye-bolt. This guy will hold the transformer anything should happen to the cross-arm. We then remove ıe block and fall and are ready to connect the transformer to ne. J. J. GAFFNEY.

Two 40-kilowatt. We mount transformers of this size in pairs y bolting two pieces of four-inch by six-inch hard pine; one iece to each side of the pole, two through-bolts going through oth pieces to the pole. These pieces should be of a length to xtend the proper distance each side of the pole, so as to make platform on which to set a transformer on each side of the pole: ıe back of each transformer being against the pole. These pieces e braced from the bottom with heavy iron braces. We have

several installations of this kind and find same very satisfactor
The accompanying photograph shows two 50-kw transforme
mounted in this way. F. C. S., MALDEN ELECTRIC CO.



METHOD OF HANGING TWO 50-KW TRANSFORMERS (F. C. S., R 1)

Thirty-kilowatt or 600-light transformer is about as large as can be hung on heavy cross-arms bolted to a single wooden pole and be safe. F. W. BULLOCK.

One-hundred-kilowatt transformers rest on platform extending from one of the poles to a stub pole erected near it.

B. J. DENMAN.

We have some 50-kilowatt transformers installed here. We received them from the General Electric Company with their regular hangers, and we hung them the same as we do any transformer, using these hanging irons. We used a Georgia pine cross-arm, four inches thick and eight inches wide. These were secured to the pole with two ordinary standard five-eighth-inch pole bolts, and we find this will carry the weight of two of this size transformers very well, and has thus far shown no sign of weakness. N. B. NETH.

The largest transformer we have in use on poles for overhead distribution is 50-kilowatt. This with two 35-kilowatt transformers constitute one bank and are hung well down on the pole, though of course out of reach from the street below. The supporting irons extend under the bottom of the transformer, and are hooked and fastened in the usual way to heavy cross-arms on the pole. T. H. T. & L. Co.

The largest capacity transformers I have had occasion to use on poles were 50-kw supported by two pieces of three-inch by eight-inch oak plank bolted to both sides of poles with four angle-iron braces to support the end of each of the two planks. Also placed 32-inch flooring on the above support for transformers to rest on. DAN BOYLE.

We have several 50-kilowatt transformers hung, by means of the straps furnished with them, on heavy cross-arms bolted to two poles set close together. W. W. FULLER.

Our largest pole transformers are 40-kilowatt. We set them on platforms bolted to the pole about 14 to 16 feet above the ground. The platform is large enough for a lineman to stand on while connecting up and working around a transformer. The primary and secondary leads are brought down from the overhead lines to a cross-arm just above the transformer.

W. H. FELLOWS.

Forty-kilowatt, put on a platform built between two poles.

R. N. KIMBALL.

Thirty-five-kilowatt, on plank platform on top of 20-foot stub also bolted to pole. H. A. SPRAGUE.

Fifty-kilowatt transformers, single, two or three-phase, ar readily installed on poles, the standard method being shown by photographs herewith. L. L. ELDEN.

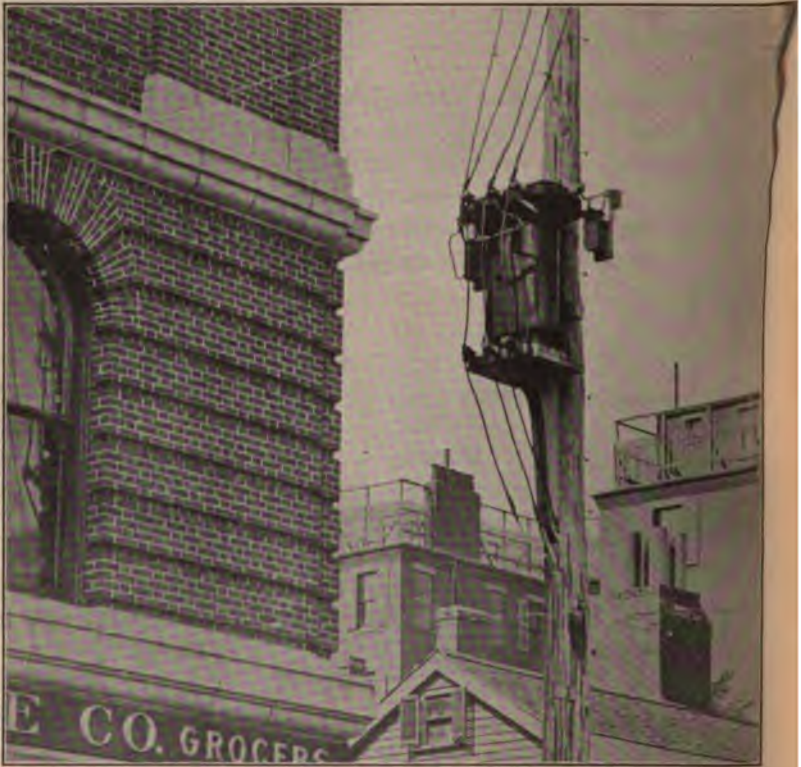


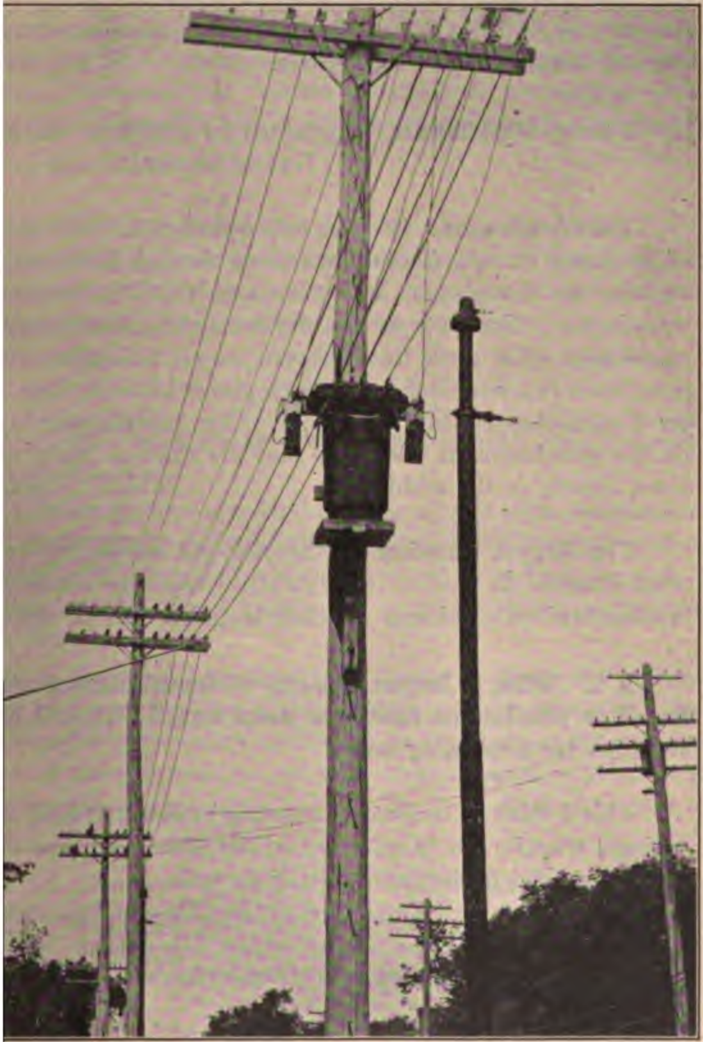
FIG. 1—METHOD OF HANGING 50-KW TRANSFORMER (L. L. ELDEN, R 1)

Thirty-kilowatt, set on a platform built by bolting two cross-beams to pole, with a platform on them. Cross-beams thoroughly braced. Part of the weight also taken on transformer hooks, which hang on an arm bolted and braced to the pole.

J. L. MOORE.

hirty-kilowatt. This size may be hung with safety on the ry standard arms with the transformer pole double-armed.

A. T. Lloyd.



—Method of Hanging 50-Kw Transformer (L. L. Elden, R 1)

wenty-five-kilowatt. Suspended on cross-arms by regular furnished by the manufacturer. W. H. Greenslit.

The Colorado Springs Elec. Co.

Twenty-five kilowatt; three transformers on platform supported by two heavy poles. GEO. N. TIDD.

Twenty-five-kilowatt. In place of wooden cross-arms we use two-inch angle irons bolted firmly to pole; transformer is bolted top and bottom to these angle irons. E. R. FRENCH.

Twenty-five-kilowatt. Supported by well-built platform.
TOLEDO RAILWAYS AND LT. CO.

Twenty-kilowatt. We put one transformer on a short arm of hard pine or oak, fastened with two through bolts to the pole, to take the hooks, and a smaller arm for the bottom of the transformer. For two, we use the same thing, one on each side of the pole. For three transformers, we set two poles seven feet apart with two four-inch by six-inch beams between them, having an X-shaped truss in the middle. One transformer is placed on the two beams at each pole and the third is hung over the truss directly in the middle. H. D. LARRABEE.

The largest transformer that we use supported by cross-arms attached to poles is 10-kilowatt. Anything above this size is supported on platforms attached to poles. E. H. MATHER.

R 2. What is largest capacity of transformers advisable to install on pole line on two-phase motor work? What is best construction for suspending same?

This I think is covered in answers to R 1. Would add that a single transformer is mounted in the same way, but platform is not extended to the other side of the pole.
F. C. S., MALDEN ELECTRIC CO.

We have two 20-kilowatt transformers. Pole is double-armed and well braced. R. N. KIMBALL.

R 3. What type of transformer—air-cooled, oil-cooled and water-cooled—has experience shown to be the most satisfactory for high-tension work, i. e., for voltages exceeding 25,000?

We use oil and water-cooled, delta-connected, 450-kilowatt groups at generating end; and self oil-cooled, three-phase, two-phase, 400-kilowatt groups at substation; we have never had any trouble with them. THOMAS GRAY.

We have no trouble with self oil-cooled 11,000-volt transformers. We have less trouble with our high-tension lines of this voltage than with any other link between the boiler and the lamp. J. L. MOORE.

Oil and water-cooled transformers are generally used with such potentials. A modern transformer-maker would hardly advocate air-cooled transformers for 25,000 volts with guarantees that would be attractive to the purchaser.

F. D. SAMPSON.

For 25,000 volts and over, transformers are generally water-cooled and oil-filled.

They are rarely water-cooled below 25,000 volts, because air-cooled transformers have the advantage of being nearly fireproof. Burnouts with air-cooled transformers are very rare, because a low temperature can be maintained at all overloads by varying the air blast.

As to simple oil-insulated transformers—these can be used only in units up to about 1000-kilowatt. Above this size it becomes absolutely necessary to cool by air or water, as the external surface of transformers larger than 1000-kilowatt is insufficient to radiate the internal losses. H. A. STRAUSS.

In all conditions of high-voltage and lightning charges, the oil-filled transformer seems best adapted and is a valuable protection to the life and safety of the transformer.

C. C. GARTLAND.

Water-cooled. This seems also to be the favorite of the underwriters, so far as their engineers have entered into the discussion of the subject. RALPH R. LAXTON.

R 4. What is considered good practice in changing oil in pole-line transformers?

This year we started to replenish and renew oil in transformers, but found, after an investigation, that the oil did not need changing, so abandoned the scheme. However, whenever a transformer is returned we remove old oil, and put in new oil when transformer is taken out again.

THE COLORADO SPRINGS ELEC. CO.

Oil should be inspected at least every two years. Drawing some from bottom of each transformer will tell the condition of same. R. N. KIMBALL.

R 5. Has any one experimented with any system of lightning arresters or spark-gaps across transformer terminals that will prevent or reduce the burning out of transformer primary fuses during lightning storms?

We had several transformers with spark-gap across terminals during the summer of 1905. These transformers caused more interruption to our service during lightning storms than we had previously had without them, and as only about two per cent of our total number of transformers were equipped with these, and as we did not lose any transformers that were not equipped with them, the writer hardly sees that there is any advantage in installing spark-gaps.

F. C. S., MALDEN ELECTRIC CO.

Put in solid copper wire in place of fuses, and use any standard lightning arresters. B. A. SCHAK.

Well-designed primary and secondary lightning arresters will assist very materially in reducing the blowing of fuses installed on the primaries of the transformers protected. M. O. TROY.

R 6. (a) In the use of 'bus lines for customers, do you use a 'bus line for each block of buildings, or do you sometimes extend the 'bus lines for more than one block? If so, how far? (b) What

advantage is there in limiting the length of such 'bus lines? Reference is now made to a single-phase alternating-current house-to-house distribution outside of the main business section of the city.

In Chicago, 'bus lines are usually limited to one block if the load in the block is twenty kilowatts or upward. If smaller, secondary mains are extended over two blocks or more. There are comparatively few locations in residence territory where it has been found of any advantage to interconnect secondaries.

H. B. GEAR.

In some cases we cover as much as three blocks with 'bus lines from one transformer. This is done, when possible, to reduce the number of small transformers, together with investment, core losses, *et cætera,* and use a larger transformer. However, where the load is fairly large we use a transformer to each block.

THE COLORADO SPRINGS ELEC. CO.

We have successfully operated for a number of years a three-wire secondary system covering eight blocks and feeding 50 to 60 residences; also another similar system with about 40. Six transformers banked in the first case and five in the other case.

E. R. FRENCH.

Extend them as far as practicable, regardless of blocks. The limit is governed by the relation between core loss and interest charge on copper—practically a slight modification of "Kelvin's law." The advantage in efficiency is so great in favor of large units well loaded, as against a number of small transformers, that the difference will justify a considerable investment in copper. Furthermore, the difference in first cost is frequently in favor of large units plus the copper. For line secondaries always use either three-wire or three-phase system of distribution with grounded neutral.

RALPH R. LAXTON.

We sometimes run 'bus lines in residence districts as far as 500 feet. The drop in voltage or the large amount of copper necessary renders it disadvantageous to run any greater distance from the transformer, in the ordinary case.

A. T. LLOYD.

R 7. Is there any reason why a transformer placed on the end of a line, with good lightning protection, should break down under normal load sooner than one under same load placed elsewhere on the line? Has any one found that it does?

It is generally supposed that the lightning will break down transformers on the ends of the line more readily than those placed elsewhere. We believe it is a good practice, where possible, to extend the line beyond the last transformer and place lightning arresters at the end of the line as well as at the transformer. EDISON ILL'G CO. OF WEST CHESTER.

We have lost three transformers on the same pole, with conditions as named in this question. The line has five pairs of lightning arresters to the mile. This transformer will blow its fuses, as well as the branch junction fuses, nearly every time there is the slightest lightning storm. There are other transformers on this branch, but with the exception of the one next to the one in question, they rarely give any trouble. We have installed three extra lightning arresters on this branch, one pair on transformer pole, with kicking coil in each side of circuit, but have had no storms since to try it. We have had arresters on this pole blown all to pieces. W. H. FELLOWS.

I should judge that a transformer on the end of a circuit would be more likely to be damaged by lightning than transformers elsewhere, unless lightning arresters were placed very near the end of the line. I have found that we have more transformers break down on the end of our lines than elsewhere, and at three different times have found a transformer that is located on a very long line (being the last one on this line with no other transformers within two-thirds of a mile) that invariably burns out or is damaged during a lightning storm.

F. C. S., MALDEN ELECTRIC CO.

If on a long high-voltage line, the high voltage due to capacity of line might cause the transformer to burn out. On a low-tension distribution system the low voltage with same connected horse-power load would call for more current and might cause it to heat excessively and burn out. Never knew of such a burnout to occur. M. C. TURPIN.

A transformer located on the last pole of a circuit seems to be particularly subject to destruction by lightning. This is probably due to the tendency of the lightning charge either to enter at the end of the line or, entering elsewhere, to run to the end and break down the insulation at that point. The remedy is to extend the line one pole beyond the transformer and locate lightning arresters on this pole. A. T. BEAUREGARD.

No. We have had more transformers damaged by lightning in the middle of lines than on the end. If possible, extend primary wires one or more sections beyond last transformer and then install lightning arresters. E. R. FRENCH.

I have been unable to find any good reason why a transformer placed on the end of a lighting line will break down sooner than one of the same capacity, operating under like conditions, elsewhere on the line, but I have found that they do. In fact, transformers having less than the rated capacity in sockets wired up, to say nothing of the actual number of lamps lighted, have "gone out" repeatedly, when other transformers of same capacity, overloaded have stood the test. L. W. GREENE.

See no reason for it, and have not observed that breakdowns are more common in such localities than elsewhere.

RALPH R. LAXTON.

(Practically concurrent opinions expressed by R. W. KIMBALL, ANDREW F. HALL, THE COLORADO SPRINGS ELEC. CO.)

R 8. What progress, if any, is being made for the grounding of secondaries? Is there any standard method yet adapted for universal practice?

In Chicago the neutral point of every three-wire transformer and one side of every two-wire transformer is grounded. No more trouble has been experienced with transformer burnouts since the practice of grounding was established, and no other disadvantages have been experienced as the result of a grounded neutral. On the contrary, several cases have arisen in which the grounded neutral served to prevent injury to consumer's property due to primary lines being crossed with secondary.

H. B. GEAR.

This company makes a practice of grounding all secondary services up to and including 230 volts. L. L. ELDEN.

One side of every secondary circuit should be perfectly grounded. It is preferable to ground one side of each service at or near the point of entrance to the building. If it is a three-wire system, ground the neutral side of each service.

E. C. DEAL.

Drive a one-inch galvanized-iron gas pipe down to the moist earth, which will serve as a satisfactory substitute for a ground-plate. Plug the pipe about three inches from the top with asbestos. Make a spiral of one end of a No. 6 wire and solder into pipe, filling the entire three inches with solder. Run the No. 6 wire in continuous length to secondaries. W. H. GREENSLIT.

We have grounded all our secondaries in every installation. We have for several years required that the service wires in buildings should be run into the basement. We require that contractors doing wiring in houses run a No. 4 wire from the point of entrance of the service wires to a point near the water-pipe entrance outside of the meter and connect it to the water pipe outside the meter by an approved ground clamp. We connect the other end to one side of the service ourselves after testing the insulation resistance of the house wiring. W. E. H.

National Electrical Code recommends grounding neutral every 250 feet. Ground wire soldered to a brass plug, which is screwed into the end of a piece of galvanized pipe driven six or eight feet into the ground, makes a good ground for this purpose and is recommended by underwriters for lightning arresters located at a distance from station. RALPH R. LAXTON.

R 9. Do gas companies anywhere permit the connecting to their pipes of ground connections from secondary electric systems?

Ground connections for secondary electric systems should not be made to gas pipes. Gas meters will not carry any amount of current without melting off the lead or soldered connections, and the iron pipes do not provide reliable grounds.

DUDLEY FARRAND.

It is not good practice to ground secondary electric systems on the gas pipe. It is better to ground them on the water pipe. We believe the gas company should not permit it. W. E. H.

R 10. Is the grounding of secondary electric systems by connection to water pipes being carried out anywhere in the country with knowledge and consent of the water company or municipality owning or controlling the pipes, and, if so, where?

No objection is made by a number of the towns and cities served by this company to the attaching of grounds for secondary mains to the water pipes. L. L. ELDEN.

In grounding the neutral wire of our alternating-current three-wire secondary circuits, we attach to fire hydrants or water pipes; in the latter case always make the connection ahead of the house shut-off cock. We own the water system, so have not needed permission from municipality; however, in the three years during which we have followed this practice, no trouble whatever has resulted therefrom. S. R. INCH.

The grounding of secondary electric system by connections with water pipes has been carried out in the city of Newton and town of Watertown with the consent of the water company owning and controlling the pipes and of the municipality through its inspector of wires. W. E. H.

In Chicago secondaries are grounded to water pipes, in addition to the grounds described in the answer to R 13, in cases where water pipes are conveniently accessible to the service wires.

No damage has been done and no objections have been raised by the municipal authorities. H. B. GEAR.

R 11. Is the grounding of secondaries to water pipes in any way detrimental to the pipes? Is there any trouble to be anticipated from a universal application of this practice?

There is no trouble to be anticipated from the practice of using water pipes for grounds for secondary mains and it is not detrimental to the pipes if properly done. L. L. ELDEN.

Fluctuating voltage is likely to occur where secondaries are parallel with street-railway lines and are grounded at more than one location. TOLEDO RAILWAYS AND LT. CO.

To ground the secondaries to water pipes is in no way detrimental to the pipes. We have it in practice throughout two townships and anticipate no trouble from the application.
W. E. H.

Grounding of the secondary neutral to a water main can cause no harm to the latter if a heavy connection is made to the main at but one point, preferably near to the transformer. With but one point thus connected, no current flows in the water mains except during the moment of the occurrence of a ground on either of the outer wires. G. R. RADLEY.

R 12. Where water pipes are not available for ground connections, either because they are not present or because their use is prohibited, what is the most satisfactory means of making effectual and permanent grounds for secondary systems?

If possible, dig or drive to permanent moisture in the earth, or plant copper plate at some point where surface water may keep the earth permanently wet. If necessary, it is better to run a heavy ground wire for a considerable distance to get a good ground rather than take chances on one where permanent moisture is not obtainable.

EDISON ILL'G CO. OF WEST CHESTER.

Ground connections may be made by driving a 16-foot length of one-inch galvanized-iron pipe into the ground at the base of the pole, leaving about six feet above the surface. The ground wire is brought down the pole and soldered into the top of the pipe, the wire being twisted into a small coil which just fits the inside of the pipe. This method of grounding is comparatively inexpensive and has been found to be equally as effective as a 12-inch by 12-inch copper plate buried six feet under the ground.

H. B. Gear.

The use of iron pipe driven into the ground a sufficient distance to secure a satisfactory ground, is a practical but expensive substitute for the use of water-pipe connections for grounds.

L. L. Elden.

Where water pipes are not available for ground connections, gas pipes could be used, provided the connection to ground is made outside of the gas meter. If there is neither gas nor water pipe, a copper plate buried in the damp earth and filled around with crushed coke makes a good ground. W. E. H.

R 13. What have you found to be the most satisfactory method of making ground connections of secondaries to water pipes? Give details.

Brass plugs screwed into pipe which is tapped about half-way through. If possible, tap at least three lengths of pipe and bind the taps together around the joints. Ralph R. Laxton.

The most satisfactory method of making ground connections for secondary to water pipe is to run No. 4 rubber-covered wire from near the point of entrance of the secondary to a point on the water pipe outside of the meter. A special clamp is then soldered to the end of the No. 4 wire and attached to the water pipe

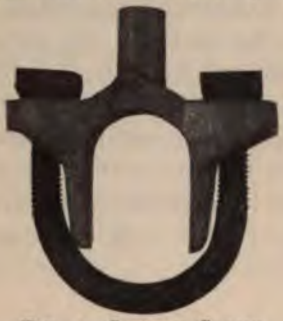


FIG. 1—GROUND CLAMP

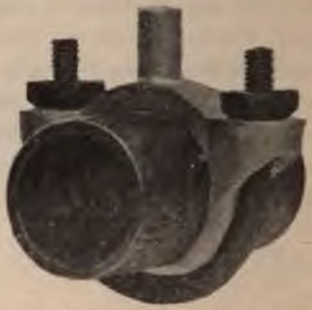


FIG. 2—CLAMP IN POSITION ON PIPE

outside the meter and fittings. I give details as to clamp.

W. E. H.

Connection is made to the service wires on the line side the customer's service switch, from which point a No. 4 wire

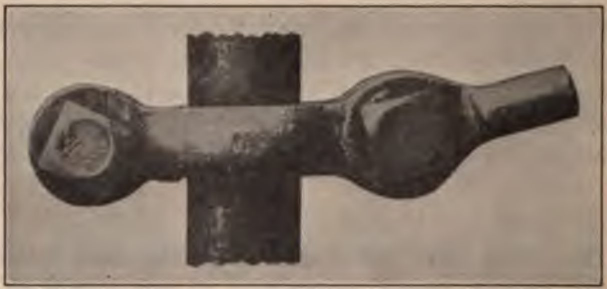


FIG. 1—CLAMP FOR GROUND CONNECTION TO WATER PIPE

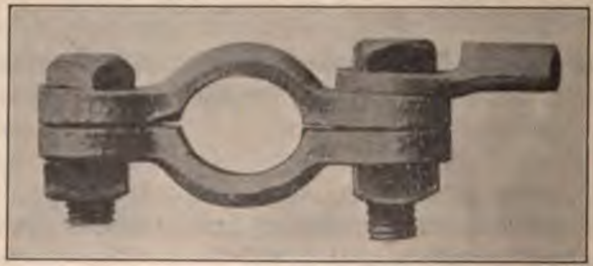


FIG. 2—CLAMP (SIDE VIEW) WITHOUT PIPE

run and connected to the water pipe outside the service cock in the cellar by means of the clamp shown. L. L. ELDEN.

R 14. State where articles giving information on the rounding of secondaries may be found in recent issues of elec-ical journals or association records.

Electrical World and Engineer, S. Bingham Hood. About)01.

Electrical World and Engineer, R. S. Hale. January 16, 1904.

Electrical World and Engineer. Legal Status of Grounding condaries. March 18, 1905. C. W. HIGGINS.

Write Inspection Department, Associated Factory Mutual re Insurance Companies, 31 Milk street, Boston, Mass., for py of *National Electrical Code with Explanatory Notes.*

I know nothing more explicit on the subject of grounds.

RALPH R. LAXTON.

R 15. What method can be employed to determine if the ad on an alternating-current secondary system is balanced?

For ascertaining the maximum load on transformers or the lancing of the secondaries, maximum-demand indicators are ry useful, as they will record the maximum whenever it occurs. indicating wattmeters or ammeters are used, measurements ust be made at the time of the maximum, and this usually can ly be approximated. J. S. CODMAN.

The installation of accurately-adjusted recording voltmeters points where you think the load is lightest and also at points here you think it is heaviest; also have voltage taken with a rtable indicating voltmeter at the service switch of each cus-mer on the secondary system. Make tests repeatedly at fixed tervals, then check with the recording voltmeter, also with the ltmeters at power-house. If it is a very troublesome case and e system is a large one, you should also make ammeter tests, hich is a simple matter if you have a late style current-trans-rmer, which can easily be put around the wire and connected an ammeter and readings taken with but little time and ouble. E. C. DEAL.

The use of cable-testing current-transformers, such as the eneral Electric Company manufactures, is the most desirable method. Next best, use the ordinary series ammeter near transformer on neutral wires. If there is a deflection of the needle the load is out of balance. When the load is balanced there should be no reading on ammeter. W. H. GREENSLIT.

The split-ring transformer with ammeter can be employed to determine the balance of a secondary system. The saving in time by the use of this instrument will very soon pay for its cost. PAUL F. WILLIAMS.

By running pressure wires back to station and using a voltmeter on each side of system, or using a portable current-transformer and ammeter on the spot during times of varying load and averaging. A. PETERS.

A portable series-transformer and ammeter, such as are manufactured by the various companies manufacturing transformers, are valuable in making observations of this nature when desirable. The installation of some of the various demand-indicator apparatus on the mains will also determine the actual conditions. L. L. ELDEN.

(Practically concurrent opinions expressed by W. T. OVIATT, WARREN PARTRIDGE, F. C. S., MALDEN ELECTRIC CO., GEO. N. TIDD, THE TOLEDO RAILWAYS AND LT. CO., RALPH R. LAXTON.)

Voltmeter and ammeter. R. N. KIMBALL.

R 16. Has the mercury arc rectifier been used on commercial direct-current arc lines, from alternating-current primaries with constant-current transformers? What has been the result? What are its advantages? What is the life of the rectifiers designed for 6.6 or 7 amperes?

Up to date, the system has not proved a success.
A. PETERS.

The mercury arc rectifier is now being used to a limited extent for supplying direct-current arc lamps from alternating-current primaries, the current being controlled by constant-current transformers. Results have been very encouraging and indicate entire ultimate success of the system.

The life of rectifier is an undetermined quantity at the present time, but tests thus far indicate that the average life will be in excess of 400 hours and possibly 1000 hours on 4-ampere outfit. Very few tests have thus far been made on 6.6 or 7-ampere outfits.

M. O. TROY.

R 17. Is there any objection or good reason why two or more transformers of the same make, type, capacity and cycles, but of different voltage, should not be operated in parallel, viz.: 1-10-kw, 1040-2080 primary—104-208 secondary. 1-10-kw, 1200-2400 primary—120-240 secondary?

Such transformers may be used successfully in parallel provided suitable conditions are created by means of balancing coils or line resistances to compensate for the probable difference in regulation of the two differently-rated transformers in question.

L. L. ELDEN.

I can see no reason why transformers wound as stated should not work in parallel, provided the winding ratio is the same in both transformers. The principal objection would be the liability to burn out a transformer with high-voltage windings, if it were required to give out rated capacity when working on a lower voltage.

W. H. FELLOWS.

It can be done. We have a General Electric, 15-kilowatt, and an American, 15-kilowatt, having the same ratio as in the case in question, connected in multiple and to all appearances, so far as temperature, drop in voltage, *et cætera*, are discernible, they work all right. The 10-kilowatt should do the same. Of course the ideal condition would be to install a 20-kilowatt transformer; at least, I am sure the respective manufacturer's agents would tell you so.

F. D. SAMPSON.

Since the ratio of transformation in these transformers is the same they should operate in parallel all right, provided they are of nearly the same capacity. Since the regulation is different in various sizes of transformers the load adjusts itself according to source of the higher e.m.f. W. H. Greenslit.

There is no reason why transformers as stated should not operate in parallel, provided the regulation is nearly equal in the different capacities. F. C. S., Malden Electric Co.

The ratios of the transformers being the same, *i. e.*, 1 to 10, they will operate in parallel. A. Peters.

The high-voltage transformer will pump into the lower-voltage transformer and they will not share their loads equally. Not advisable at all to connect in any manner stated.

Geo. N. Tidd.

It would not appear to the writer as if these transformers would properly divide the load, owing to the higher impedence of one transformer than of the other, and because the core loss on the two would be different, one of them would be supplied with a voltage different from that for which it was wound.

M. C. Turpin.

If the curve of regulation is the same for each transformer on the primary voltage on which they are to operate, they will operate satisfactorily; if the regulation curve is not the same there will be an unequal distribution of load. W. T. Oviatt.

R 18. Has an immersed switch been used, located on the pole or in the transformer vault and operated from the interior of a building so as to cut the primary current off the transformers for the purpose of saving the core loss when current is off? If installed, would the interest on investment and maintenance of such an equipment be more or less than the core loss on, say, a 25-kw transformer not in use 5600 hours per year?

The core loss per hour of a 25-kw transformer is 220 watts. Therefore, for 5600 hours it would be 1232 kilowatt-hours. This at one cent per kilowatt-hour is $12.32 for the year. This amount capitalized at ten per cent would allow an investment of $123.20. As the maintenance of such an installation would be very small and a switch installation of this character and capacity would cost less than $123.20, such an installation would be profitable. PAUL F. WILLIAMS.

It is doubtful if an immersed automatic oil-switch could be installed out of doors and made to operate satisfactorily for cutting off transformers supplying motors when the transformers are not in use, for the reason that in cold weather the oil would thicken to such an extent that an excessive amount of energy would be required to operate the switch. The following arrangement, however, might prove economical and satisfactory on combined transformer and motor installations of 25-hp and upward. The installation would consist of power transformers equipped with primary switch having a solenoid control, the solenoid to be excited from a small transformer and controlled from the motor-starting rheostat. The primary switch need be capable of opening only the exciting current of the circuit. Such an arrangement would insure the transformers being disconnected every time the motors were shut down and automatically reconnect them to the source of supply when starting up the motors.

The increase in cost of the automatic features required for such an installation would be approximately $90. On the ordinary basis of interest and depreciation charges, this would represent an annual investment of about $9.00. The saving of 5600 hours per year in core loss would represent about $13 at one cent per kilowatt-hour on a 25-kw installation—that is, after allowing for the increase in losses due to the automatic features. The proposed arrangement would therefore prove economical on installations of 25 kilowatts and over. M. O. TROY.

R 19. Will a choke coil in circuit between transformer and cutout prevent blowing of fuse due to lightning?

No. C. K. N., N. Y. ED. CO.

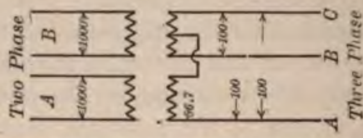
No. The reactance of coil would tend to aid the blowing of fuse, if it had any effect.

The coil should be placed between line and fuse, rather than on transformer side. RALPH R. LAXTON.

It is doubtful if a choke coil between a transformer and its cutout will prevent the blowing of fuses due to lightning. It is believed that better protection would be afforded by an installation of lightning arresters on the primaries and secondaries of the transformer, installed at the transformer. M. O. Troy.

R 20. Give a diagram of the "Scott connection" and explain its advantage and application.

One transformer is wound with a ratio of 10 to 1 with a tap in the middle of the secondary to which is connected one end of the secondary of another transformer having a ratio of .866 to 1 (1 to the square root of 3 divided by 2), the other end leading to the line. The advantage lies in the fact that the generating apparatus may be wound for two phase and to save copper costs, the transmission line may be three phase.

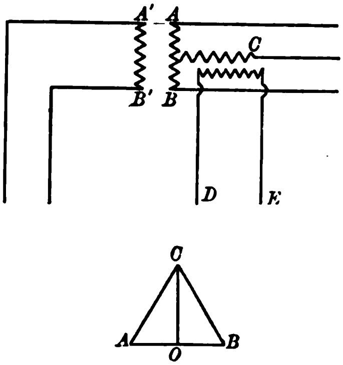


Three-Phase-Two-Phase Transformer Connection

E. A. M., N. Y. Ed. Co.

The "Scott" connection consists in an arrangement of two transformers by which a transformation between two-phase and three-phase current may be effected. It may be used to change two-phase to three-phase, or *vice versa*. It is of advantage where the one kind of current is generated and it is necessary by reason of the apparatus on hand to use the other kind. It is particularly advantageous when it is desired to furnish transmission line when two-phase generators are used. By changing to three-phase for transmission, of course considerable copper is saved.

The diagram given below will explain how this transforma-
n is effected:



THREE-PHASE-TWO-PHASE TRANSFORMER CONNECTION

Let ABC be an equilateral triangle, A, B and C representing the three
es of a three-phase distribution:

$$AC = AB = BC$$

CO is a perpendicular dropped from C to the middle point of AB so
t AOC is a right angle triangle and

$$AO = 1/2\, AC = 1/2\, AB = 1/2\, BC$$

Then $AC^2 = AO^2 + OC^2$

But $A\ O^2 = 1/4\, AC^2$

Then $AC^2 = \frac{AC^2}{4} + OC^2$

$$OC^2 = AC^2 - \frac{AC^2}{4}$$

$$OC^2 = 3 \times \frac{AC^2}{4}$$

Taking the square root of both sides we get

$$OC = 1/2 \sqrt{3} \times AC = .866\, AC = .866\, AB$$

Or by trigonometry :

As ABC is an equilateral triangle, the angle $\alpha = 60^\circ$

Then $\frac{OC}{AC}$ = sine of α

The sine $60^\circ = 1/2 \sqrt{3}$

Then $OC = 1/2 \sqrt{3}\, AC = .866\, AC = .866\, AB$

From the above it is seen that by taking two transformers,
e having .866 times the turns the other one has, and connecting
e terminal of the former with the middle point of the wind-
gs of the latter and impressing three-phase voltage on the ter-

minals ABC, as shown in sketch, we can get two-phase voltage from A^1B^1DE or *vice versa;* by impressing three-phase voltage on A^1B^1DE we can get three-phase voltage from points ABC.

M. C. TURPIN.

The "Scott" connection is used to change three-phase into two-phase, or *vice versa.* The scheme consists in using two transformers, the primary of one being connected to say A and B of the three-phase wires. A centre tap is taken off the primary of this transformer and is connected to a tap taken off at 86.6 per cent of the primary winding of second transformer. The free end of second transformer, farthest from 86.6 per cent tap, is connected to C of the three-phase wires. The secondaries of the two transformers thus connected will give two-phase current.

A. PETERS.

The so-called "Scott" connection is one used to obtain two-phase current from a three-phase system, or *vice versa.*

CHAS. W. STONE.

R 21. Which is the better practice on a two-phase motor circuit—two single-phase transformers or one multiphase?

One multiphase is more compact. In using two single-phase transformers, if one is destroyed it is usually possible to find another for a makeshift. This is not always the case with the multiphase.

A. PETERS.

Depends on conditions. Where two-phase motor business constitutes only small portion of connected load, prefer single-phase transformers, as they are available for lighting, *et cætera,* if removed; likewise, single-phase can be carried in stock, applicable to all new or repair work. Simplifies the system.

D. L. OTT.

For most central stations it is more convenient to use the two single-phase transformers, because stock transformers may be utilized for either incandescent lighting or motors at pleasure.

The polyphase transformer is not so satisfactorily adapted for the incandescent lighting service. DUGALD C. JACKSON.

(Practically concurrent opinions expressed by M. C. TURPIN, H. D. LARRABEE, HERBERT MCNULTA, UNITED ELEC. LT. CO.)

Generally speaking, one multiphase. Local conditions can change this, however. W. H. WOLVEKAMP.

R 22. Has serious trouble been experienced by way of breaking down insulation, etc., as a result of suddenly exciting large static transformers under full primary voltage with the secondary circuit open, due to the rapid variation of the magnetic flux on account of different points in the wave at which the transformer was last disconnected and again connected to the primary system?

With 75-kilowatt maximum size, not thus far.
W. H. WOLVEKAMP.

No serious trouble has been reported as resulting from suddenly exciting large transformers under full primary voltage with the secondary circuit open. It has been demonstrated by oscillograph records, and otherwise, that a transformer is subjected to unusual mechanical and electrical strains at this time and must be properly designed to withstand them. M. O. TROY.

R 23. Has trouble resulted anywhere to telephone or fire and police-alarm systems where an alternating-current secondary distribution system is permanently grounded on one side or the neutral and an accidental partial ground occurs on one of the other sides? Can such trouble be prevented, and how?

This occurred on lines of this company and attention was first drawn to it by telephone company inquiring whether we had trouble on circuit in this locality. Their instruments were being operated with one ground wire, condenser in series. Report that all bells on telephones in this territory were continuously ringing. There was also induced current on arc circuit grounded at plant, in daytime. Police and fire-alarm lines operating with one ground wire also had current on them, which city linemen were unable to locate and started trimming trees. This seems to be a serious objection to grounding secondaries. D. L. OTT.

So far as the writer knows, no trouble has been reported due to a partial ground on the secondary distribution while the neutral or other side is grounded. In the majority of such cases, trouble would probably result in the blowing of the fuses in the transformer primaries. Sectional fuses in the secondary network and fuses in the transformer primaries would probably minimize the possibilities of such accidents. M. O. TROY.

R 24. In a bank of transformers with three-wire secondaries properly balanced, can any one transformer be overloaded if the total number have capacity for load, and if so, to what extent will the others protect it?

One transformer may become overloaded due to difference in regulation. The junction fuses, which should allow for approximately 50 per cent overload in each transformer, will protect it. B. C. ADAMS.

Not if the transformers have the same electrical constants.
W. H. WOLVEKAMP.

R 25. Do you consider grounding one side of secondary for protection in case of cross or transformer breakdown sufficient protection against lightning where long secondaries are in use; that is, will this safely displace secondary arresters?

No, unless one side of secondary is grounded about every 500 feet. A. T. BEAUREGARD.

This is not sufficient to rely upon as a safeguard; you are running chances of damaging transformers. Lightning arresters should be used regardless of this. CLAYTON F. GEIGER.

One side of secondary grounded will take care of a cross, and of lightning also to a certain extent, but if in a neighborhood troublesome from lightning, use one low-tension arrester on wire not grounded. Beacon Light Co.

No. W. H. Wolvekamp.
C. K. N., N. Y. Ed. Co.

Grounding one side of a secondary distribution is not sufficient protection against lightning, and lightning arresters should not be displaced. If lightning strikes the ungrounded side of the secondaries, it will tend to discharge itself through the transformers and to the ground on the other side. The high-frequency discharge passing through the transformer would in all probability break down the outside turns of the secondary winding, as the reactance voltage would be greatest at this point. Lightning arresters should, by all means, be used. M. O. Troy.

R 26. What has been the experience in the smaller stations with grounded secondaries as to current loss and lightning effects?

The writer knows of no case in which grounding secondaries has resulted in appreciable increased current loss or losses due to lightning effects. M. O. Troy.

R 27. Is it practicable to install transformers in manholes likely to fill up with water. Is there a transformer on the market that meets that service? If so, please state relative cost to overhead transformers.

There are few manholes that are not sometimes filled with water, therefore all transformers designed to go in manholes are built to stand constant immersion. Chas. W. Stone.

General Electric type "H" subway transformers will operate satisfactorily in manholes likely to fill up with water, particularly where the holes would be filled with water only temporarily. The increased cost over pole-type transformers is approximately 15 per cent. M. O. Troy.

R 28. How often do you find it necessary to remove covers from transformers installed on overhead circuits to ascertain the height of oil and to refill these transformers with oil sufficient to cover the coils?

Make a practice of doing this every spring before the lightning and hot weather pay us a visit. F. D. SAMPSON.

A record of burned-out transformers, covering two seasons, showed that the oil was below the top of the coils in nearly every instance. The lines were well protected by lightning arresters, but in some cases transformers of recent and well-known make burned out without any apparent cause other than the lack of sufficient oil. H. B. GEAR.

It is good practice to remove the covers from pole-type transformers and inspect the height of the oil in the tanks, and its condition, once a year. In making this inspection, it is advisable for the inspector to be provided with a glass tube by which he can take a sample of oil from the bottom of the case to see if any water has gotten into the oil. It is only necessary to close one end of the tube with the finger, lower the other end of the tube to the bottom of the case, remove the finger and give the oil a chance to rise in the tube, then close end of the tube again with the finger and raise the tube. If an appreciable amount of water is in the oil, it will have collected at the bottom, and the proposed method affords a ready means of taking a sample of the bottom oil. M. O. TROY.

Transformers should be inspected for height of oil every spring before the season of storms begins, and at same time note if there is any water in bottom. F. M. VANDER VOORT.

Covers are removed every year, and oil is added about once in three years. B. C. ADAMS.

R 29. What ratio to total number of sockets connected (i. e., connected load) should a transformer have when connected, first, to a single residence; second, when three or four houses are

connected from the one transformer; third, when eight or ten are so connected?

We generally install transformers on residential work, having about one-half the capacity of connected load.

UNITED ELEC. LT. CO.

Under usual residence-lighting conditions in cities of 50,000 and less, it would be safe to assume that for every 16-cp lamp connected a transformer of a capacity equivalent to 50 per cent of the total number of lamps installed would be sufficient. In a modern flat where there are eight tenants, each having twenty lights per apartment or 160 in all, we have a 5-kw transformer installed. At peak-load hours we have observed less than two per cent volts-drop—total number of lamps burning, fifty-six 16-cp equivalents. In any case, modern transformers of good design should take care of abnormal conditions for short periods such as are met with in these cases. F. D. SAMPSON.

For commercial use we put up transformer capacity equal to about 75 per cent of the load connected. For single residence about 50 per cent, but never smaller than one-kw transformer, for three or four residences from 6 to 10-light capacity each; for eight or ten residences, of 5-light capacity each, of course one must be guided in a measure by the social position of the customer. L. W. GREENE.

First, the size of transformer when connected to a single residence should be about 75 per cent of the maximum burning load of that residence.

Second, where three or four houses are connected the transformer should be at least 100 per cent of the maximum burning load of the largest house or at least 25 per cent of the total burning load of all houses connected. When eight or ten are so connected the transformer ratio should be about 20 per cent; though in all cases ascertain the maximum load of the largest residence connected, and install a transformer large enough to take care of this maximum with about eight lights per residence for the remainder connected. This answer refers to the average residence district. PAUL F. WILLIAMS.

Wright demand ammeter in service several months on primary of a 300-light transformer, about ten residences, registered about 25 per cent of connected load. D. L. OTT.

First, two-thirds; second, one-half; third, one-third.
H. D. LARRABEE.

(a) One-kw transformer. (b) Two-kw. (c) Five-kw. Thirty lamps for each kilowatt of transformer is a very safe ratio.
BEACON LIGHT CO.

About 20 per cent of connected load is figured for the capacity of the transformer. B. C. ADAMS.

R 30. Has any company tried the following system, and, if so, with what success? Adopt a system (such as a railroad wrecking train) to take care of interruptions to service by having a transformer of a certain size all ready connected to flexible wires of sufficient capacity and insulation and so arranged as to be readily placed on a wagon or automobile and speedily transported to point of demand and temporarily connected into circuit, allowing transformer to remain in wagon and placing a man on duty as watchman till daylight, when regular gang would arrive and make permanent repairs.

Such a system would only take care of interruption due to transformer or cutout troubles and the improvement in the service would not justify the expense. A. T. BEAUREGARD.

This system has been in operation on the cables of the Electric Supply Department at Sheffield, England, during the past two years. The equipment is mounted on a wagon and hauled by horses to any desired point.

Photos and detailed description appeared in the English engineering journals when the apparatus was first put in service. Mr. S. E. Fedden is the engineer responsible for the scheme.
WM. MCDONALD.

The Madison Gas and Electric Company keeps a "trouble transformer" on a wagon ready to be hauled out at any time. The transformer is fitted up to be connected to the circuit immediately upon its arrival at the place where required. It has been found on several occasions to be a wise precaution.

B. C. ADAMS.

The writer does not know of any central station using the system proposed, but the scheme is very commendable and worthy of careful consideration. M. O. TROY.

S—LAMPS

S 1. Where a company furnishes and renews standard size, clear-glass incandescent lamps, should special higher-priced lamps be charged for, and if so, on what basis should the charge be made?

If you have free renewals, and want to furnish Meridian or Gem lamps, figure out the kilowatt-hours in the life of the lamp and then the same in ordinary lamp consuming about the same amount of current, usually a 32-cp. Find out how many kilowatt-hours you get in the ordinary lamp for each cent of cost, and then allow a credit of one cent on the new lamp for each of that number of kilowatt-hours. C. K. MUNNS.

Should be charged for at regular retail selling price.

H. A. STRAUSS.

We charge for special lamps at a rate of forty cents for frosted and colored lamps up to 16-candle-power.

LUDWIG KEMPER.

It is a good practice to charge enough for the higher-priced special lamps to cover the increased cost.

EDISON ILL'G CO. OF WEST CHESTER.

Special high-priced lamps should be charged for at cost.

W. E. H.

(Practically concurrent opinions expressed by J. J. CAGNEY, W. W. FULLER, L. W. EMERICK.)

A lighting company is justified in making a small profit on special lamps to cover cost of handling, but it is probably better practice to accommodate customers by selling special lamps at cost, less the cost of the standard lamp, which would be renewed free.
PERCY INGALLS.

Think that the higher-priced lamps should be charged for and that the charge should be the difference between the cos price of the standard lamp and that of the special lamp.
H. B. LARRABEE.

(Practically concurrent opinions expressed by ANDREW F HALL, E. R. FRENCH, L. D. NORDSTRUM, E. A. M., N. Y. Ed Co., C. E. INMAN, J. W. C., E. E. I. Co. BOSTON.)

No. J. J. GAFFNEY.

S 2. Is the practice of giving free lamp renewals good business policy, and is it gaining or losing adherents?

It is surely good business practice for a lighting company to furnish free lamp renewals, so that a standard lamp of high efficiency may be used by all the customers and that old lamps may be renewed when they are practically useless, otherwise they would be retained by customers to the discredit of the lighting company.
EDISON ILL'G CO. OF WEST CHESTER.

In our opinion, free renewal of lamps is good business. Only in this way can the station manager control the quality of lamps to be used on his lines. If the consumer buys his own lamps, he may not only use them long past their efficient life, bitterly complaining at the same time of his poor lighting, but he will often use less current than he really needs in order to save his lamps.
F. TOBEY, JR.

We consider free lamp renewals to meter customers good policy. We renew lamps when they begin to blacken, and do not wait until they burn out. We sell light, and good light is our best advertisement.
LUDWIG KEMPER.

The practice of giving free lamp renewals is good policy and is steadily gaining adherents. Considering the total cost of illumination to consumer, the central-station company, by intelligent selection and purchase in large quantities, can buy lamps to better advantage than the customer and thus keep the cost for this part of the lighting expense at a minimum. In other words, a central-station company by furnishing free renewals can unquestionably furnish a cheaper and better service than where the customer is allowed, or compelled, to purchase his own renewals.

F. W. WILLCOX.

In these days of more or less open hostility to all public-service corporations, it is necessary to please customers as far as possible and give them the best service for the money. Where free lamps are not furnished by the company, but have to be bought from supply houses and small dealers, there is more than an equal chance that the customer will not get the lamp adapted for the particular voltage at his place. As a variation of only two volts means a change in candle-power of over 12 per cent with a decrease in life in case of a higher voltage of 30 per cent, it should be the policy of the electric-light company to see that the customer has lamps exactly suited to his voltage. This is especially true where different voltages are used in different parts of the same city.

The reason for free renewals, therefore, is to give the best possible service to the customer. For this reason the company should not wait until the lamps are burnt out before renewing same, but as soon as they have fallen to 80 per cent of their initial candle-power, or begin to blacken, the lamps should be renewed. If a lamp burns dim, due to age, the chances are that nine customers out of ten will say that the voltage of the line is down and will "kick" on the service rendered by the company, whereas the whole trouble is with the old lamps. It therefore seems to me that unless the company takes special care to renew lamps, sending the renewal man around to the customer's place at stated intervals to replace old lamps as well as having a place where old lamps can be exchanged for new lamps the whole policy of free renewals falls down. There is no advantage gained by the electric company in giving free renewa unless the service is maintained at a high standard.

Van Rensselaer Lansingh.

I think the practice should be discontinued. Many frauds are perpetrated on the electric companies that give free renewals and I believe it would tend toward better feeling between the customers and the companies if the companies reduced the price of current and allowed their customers to purchase lamps where and when they pleased, but kept them informed of the advisability of changes after certain periods of burning, kept them posted as to what lamps are better for their use, where they might be obtained, thus encouraging their interest in this matter for the best results. I think the time has gone by when it is necessary for the central station to exercise control over the customer's service any more than is absolutely necessary to give him good and cheap service, the users of current are much better informed on this subject than in times back and a great many customers would prefer a cheaper rate with the privilege of using their own judgment as to renewals rather than the paternal attitude of the service company. Free renewals are all right for the lamp manufacturer, but it is a question if the central station is best served by that practice. S. S. Ingman.

Giving free lamp renewals is good policy, as it eliminates an item of cost to the customer, which, though small, is constantly recurring. Percy Ingalls.

We believe the practice of giving free lamp renewals is good business policy and the only thing for central stations to do. In our opinion it is gaining adherents rather than losing them.

T. H. T. & L. Co.

We believe that good service can only be insured by that full control over the incandescent lamps afforded by a liberal system of free lamp-renewals. J. W. C., E. E. I. Co., Boston.

Yes, undoubtedly; and it is gaining in popularity every day. It keeps up standard of your system and creates a wholesome tendency to burn more electricity. Watch the gas people clean up their tips and Welsbach renewals; that's a "sign of the times."

F. D. SAMPSON.

It is the policy of this company to furnish free lamp renewals, and it is regarded as good business practice to be somewhat liberal in making exchanges. We encourage lamp renewals when the bulbs become darkened and before the life of the lamp has terminated. Such practice maintains the equipment at its normal efficiency, and retains a satisfied customer.

THE BROOKLYN EDISON, E. W. PHILLIPS.

Something for nothing is what the American people are looking for. Sell your incandescent lamps for five or ten cents for a 16-cp, if you please, and other sizes in proportion, with the return of the old lamp, or give a new lamp for the return of the old one when the customer has used a certain amount of current, which will of course entail additional bookkeeping, but do not allow customers to return old lamps for new ones indiscriminately. This will also answer the question S 4. L. W. GREENE.

Yes, as thereby defective and inferior lamps are eliminated and the service kept at its best efficiency to the public a most desirable object lesson of the excellence of central-station service.

E. A. M., N. Y. ED. CO.

(Practically concurrent opinions expressed by L. W. EMERICK, H. A. STRAUSS, W. E. H., J. J. GAFFNEY, C. E. INMAN, J. L. MOORE, E. R. FRENCH, ALEX. J. CAMPBELL, J. J. CAGNEY.)

S 3. Should a company furnish the first installation of incandescent lamps free?

To furnish the first installation of incandescent lamps free is simply a small expenditure for the purpose of getting new business. Should lamps that will give over eighty per cent of their original candle-power be returned by customers, they should be returned to them. All customers should return old lamps when they want new ones, as it is a check upon their wants and gives the lighting company a chance to see the condition of old lamps.

EDISON ILL'G CO. OF WEST CHESTER.

The practice varies; some companies furnish the first installation and others charge therefor. It would seem desirable for central-station companies to furnish the first installation, as well as renewals, for the sake of having customer use a type and efficiency of lamp selected by them. Many companies to-day furnish free installation of arc lamps and Nernst lamps, and this is a more liberal policy than will be necessary for the installation of incandescent lamps. F. W. WILLCOX.

We believe it good practice to furnish the first installation of lamps, together with the usual allotment of spare lamps for renewals. J. W. C., E. E. I. Co., BOSTON.

The first installation of lamps should be furnished free if renewals are free, because it insures lamps being of proper voltage and consequently good service at the most critical time in the company's relation with its customers. PERCY INGALLS.

I think it good policy to furnish the first installation of incandescent lamps free, as by doing so I think the company would be able to obtain many more customers than otherwise.
F. C. S., MALDEN ELECTRIC CO.

For reasons given in S 2, namely, to get the right lamps for the right voltage so as to satisfy the customer, the first installation of incandescent lamps should be free.
VAN RENSSELAER LANSINGH.

We believe it to be good practice. ALEX. J. CAMPBELL.

(Concurrent opinions expressed by ANDREW F. HALL, F. TOBEY, JR., E. A. M., N. Y. ED. CO., J. L. MOORE, J. J. CAGNEY, W. E. H., H. A. STRAUSS, J. J. GAFFNEY.)

This depends on the rate. If 20 cents per kilowatt-hour, yes; if nine cents, no. L. W. GREENE.

We think that the customer, if in a residence, should stand part of the first installation, and we charge 10 cents for each lamp installed. C. K. MUNNS.

No. The first installation of lamps should be considered as uch a part of the fixtures as the shades. Sell customer lamps t cost and see that he has the right voltage to start with.

E. R. French.

Not unless competition warrants it; then call it advertising.

W. W. Fuller.

Not unless they want to pay customer for new business.

G. P. Bullis.

No.

C. E. Inman.
L. W. Emerick.

S 4. Should good lamps returned by customers be exchanged d given out again or should the customers be required to return ly poor lamps?

By all means exchange the lamps, although superficially perct; otherwise you are almost certain to antagonize your cusmer, and this must be avoided. If the lamps are "good" they n be handed out to other and less exacting consumers.

J. J. Cagney.

There should be no restriction placed on customer's returning mps. He should be allowed to return lamps as often as he likes, e company protecting itself on the lamps returned by photoetering and, after cleaning, reissuing all that are good.

F. W. Willcox.

Exchange all lamps, test them and reissue the good ones.

J. L. Moore.

(Practically concurrent opinions expressed by Douglas P. orrison, F. Tobey, Jr., E. R. French, Percy Ingalls, W. E. ., J. W. C., E. E. I. Co. of Boston, H. A. Strauss, Van Renslaer Lansingh, J. J. Gaffney, C. E. Inman, L. D. Nordrum, Andrew F. Hall.)

See answer to S 2.

L. W. Greene.

Ordinarily, any lamp that is good enough to be given out again is too good to be taken in exchange, unless the point of satisfying the customer is of unusual importance. A good plan is to try these lamps before the customer, as in many cases he will recognize that lamps are good enough to be kept in use and will not necessitate renewal. L. W. EMERICK.

Only burned-out and very dim lamps should be exchanged. Customers should be required to return only burned-out lamps for exchange, and if dim lamps are to be replaced company's inspector will call and exchange them if thought necessary.

A. O. FRETZ.

It is presumed that only poor lamps should be returned. All returned lamps should be tested and those not actually dim may be used again; the others may be employed for station work.

E. A. M., N. Y. ED. CO.

S 5. Should free lamp renewals be delivered by the company or customers be required to send old lamps in for exchange?

Lamps should be delivered to the customer wherever possible, for the reasons that a better service can thereby be maintained with more satisfaction to the customer and there is less chance of lamps being given to wiring contractors or dealers when they are delivered to the customer.

DOUGLAS P. MORRISON.

Our experience shows that the company should deliver free lamp renewals. Besides being appreciated by the customer it betters the service and increases the sale of current inasmuch as all sockets are kept filled and ready for use at all times, and also gives the company a chance to inspect the customer's premises and keep tab on the general conditions, as to poor wiring, additional lights and theft of current; saying nothing of the satisfaction to be had by the lady of the house in pounding the "Renew Boy" for the high bills, poor service, and other misdoings of the company, as she is pleased to call it. E. C. DEAL.

I think this depends a good deal on local conditions. I think it is well for a company, where it covers a good deal of area, to have local agencies wherein bills can be paid and wherein a stock of lamps can be kept, which will make it very convenient for customers to go to renew lamps. I think these agencies can be established in reliable places at a very small cost, and it will tend to bring customers to the agents themselves, and also form a good advertising medium for the company.

F. C. S., MALDEN ELECTRIC CO.

A number of companies are delivering lamp renewals to their customers. A number of spare lamps (forming a fixed proportion to the number of lamps installed) are delivered in pasteboard boxes by wagon once a month, when customer is allowed to replace the old or burned-out lamps with lamps from the spares, the only requirement being that he return lamp for lamp. The wagon on its rounds replaces the old box of lamps with a new box. In smaller cities and towns a force of boys could be employed periodically, say two or three times a year, to do the work at a minimum of expense. F. W. WILLCOX.

The answer to this is given in my answer to S 2.

VAN RENSSELAER LANSINGH.

Believe it better to deliver the free lamp renewals at a customer's premises. This insures frequent changing of the lamps, giving the customer better lighting and enables the company to know with reasonable certainty that these free lamp renewals are being used by its own customers and not elsewhere.

ALEX. J. CAMPBELL.

We are endeavoring, with encouraging results, to educate the public to send exhausted lamps to district lamp rooms. Our consumers' contracts specify that we will "supply," not "deliver," good lamps in exchange for exhausted ones. Among the beneficial results accruing are the removal of liability for damages caused on consumers' premises, reduction in number of lamp renewals, reduction and ultimate elimination of expenditure for delivery. J. J. CAGNEY.

In business districts free lamp renewals should be delivered periodically, as customers are more likely to send in a complaint of poor service than a basket of lamps for exchange. In residence districts the customer should send them in or notify the company when he is ready to have lamps exchanged. This, because it is not desirable to have lamp men going through residences. PERCY INGALLS.

On a large system we believe the only satisfactory way is to deliver lamps by regular route or schedule to the premises of the customer, taking his receipt for new lamps and receiving the burned-out lamps in exchange.

J. W. C., E. E. I. Co., BOSTON.

We make free delivery of renewal lamps upon request of the customer, and exchange at our lamp bureau new for old lamps delivered by such customer.

THE BROOKLYN EDISON, E. W. PHILLIPS.

In suburban districts deliver lamps on request or have man cover the district at regular intervals and exchange lamps. If office is near business centre exchange lamps sent in and also deliver on request by telephone or otherwise. Never refuse to exchange lamps often for good customers, as often many of the lamps returned can be used again. E. R. FRENCH.

Customers should be required to return old lamps for renewals. This mutual exchange is good for the business outside the actual monetary consideration, and you will always hear something interesting even in the exchange of lamps.

F. D. SAMPSON.

The larger companies should deliver the lamps to the customers, but in the smaller companies where they can not afford special teams for this work we think the customer should be required to send the old lamps in for exchange. W. E. H.

(Practically concurrent opinions expressed by H. A. STRAUSS, E. A. M., N. Y. ED. Co.)

It is good practice for a lighting company to make a semi-annual inspection and renewal of lamps on its system, the customers returning lamps that need changing in the meantime.
EDISON ILL'G CO. OF WEST CHESTER.

Deliver renewals when requested, and do not wait for the request if you know they are needed. F. TOBEY, JR.

Customers should be required to return old lamps for exchange. A. O. FRETZ.
LUDWIG KEMPER.

S 6. Where incandescent lamps are installed and renewed free, is it the practice to furnish extra lamps so that the consumer can replace burned-out or dim lamps?

Yes, to the extent of 20 per cent extra lamps.
E. A. M., N. Y. ED. CO.

It is good practice to allow customers to have some extra lamps to use in case of burned-out lamps. The number allowed depends upon circumstance. J. J. GAFFNEY.

The practice of leaving spare lamps with customers in pasteboard boxes is growing and is desirable, as it enables customer to keep all his sockets lamped-up, thus promoting fullest use of service; to keep all dim lamps replaced with good ones, thus promoting fullest satisfaction of service. F. W. WILLCOX.

In stores and large buildings it is well to have a few spare lamps. In residences, a lamp can usually be borrowed from one part of the house to replace a burned-out lamp in another part until the burned-out lamp can be exchanged. Extra lamps about a house get lost or broken. E. R. FRENCH.

Where the rule is adopted that lamps are installed and renewed on a customer's premises only, and not at the office (and this rule seems a good one), it is practically necessary to leave the customer some extra lamps. ALEX. J. CAMPBELL.

A certain number of extra lamps can well be left with each customer and he be held responsible for them. This because it is a great convenience, and without them there is an occasional loss of revenue. PERCY INGALLS.

It is the practice of this company to furnish extra lamps, about 10 per cent of the total installation, so that the consumer can replace dim or burned-out lamps when desired.

THE BROOKLYN EDISON, E. W. PHILLIPS.
W. E. H.

If the company maintains a department for seeing that old lamps are constantly renewed and that the service is kept up to a high standard, it will not be necessary to furnish extra lamps. In case, however, the service is not so kept up, it would be desirable to furnish extra lamps so as to aid the customer in every possible way to be satisfied with the service given.

VAN RENSSELAER LANSINGH.

Only in show-window lighting should extra lamps be left for consumer to replace those dim or burned out. G. H. CUSHMAN.

No; furnish only the actual requirements.

H. A. STRAUSS.

Do not favor furnishing extra lamps to customers unless they are willing to pay for them. Lamps are sure to be lost in the hands of most customers.

EDISON ILL'G CO. OF WEST CHESTER.
LUDWIG KEMPER.

No; such a practice would invite theft of current.

J. J. CAGNEY.

First installation should be charged to customer, in which case he can provide himself with as many extra lamps as he desires, obtaining free renewals thereafter. This will prevent an unreasonable number of extras being provided.

L. W. EMERICK.

We furnish extra lamps for the convenience of customers.

C. E. Inman.
J. W. C., E. E. I. Co. of Boston.
United Elec. Lt. Co.
Andrew F. Hall.

S 7. Do you furnish first installation of Meridian lamps and renewals free? If so, how do renewal costs compare with the cost of renewing ordinary incandescent lamps on the same basis?

We supply Meridian lamps and renewals free of charge. We also provide three and five-light clusters free of charge for store lighting, and by so doing have been able to compete with gas arcs. Considering the revenue, we think the slight additional cost of renewals worth while. United Elec. Lt. Co.

Renewals of Meridian lamps are furnished free by large numbers of lighting companies. The renewal costs are somewhat higher than standard-plain lamps, with which Meridian lamps should not be compared, as the Meridian lamp is an exceptional lamp, being a round bulb, frosted and generally tipless. The renewal cost of the new GEM-filament Meridian lamp, consuming 100 watts and giving 50-candle-power, is on the average 0.7 cent per kilowatt-hour, which is well below that of the regular 16-cp 3.1-watt frosted lamp. The new General Electric high-efficiency incandescent units, while not so artistic in appearance, will match the Meridian lamp in light distribution and efficiency at a very much reduced renewal cost.

F. W. Willcox.

We charge for first Meridians net and renew free.

Andrew F. Hall.

First installation of Meridian lamps supplied by the customer, but renewals furnished free by company. Renewal costs about 50 per cent in excess of that for ordinary lamps.

J. W. C., E. E. I. Co., Boston.

No. We charge difference in cost between standard 16-cp lamp and Meridian lamp. G. P. Bullis.

No; we furnish only ordinary clear 10-cp or 16-cp lamps with ordinary installation. J. J. CAGNEY.

We do not furnish free installation or renewals of Meridian lamps. LUDWIG KEMPER.

The cost of renewals of Meridian lamps has been exceedingly high with us; they seem to give poor service for the current consumed.

EDISON ILL'G CO. OF WEST CHESTER.

No. Too expensive. E. R. FRENCH.

S 8. What is the best way of marking incandescent lamps for the purpose of identification?

When negotiating your lamp contract, stipulate that candle-power of lamps and initials of your company be etched on same while in process of manufacture; this seems to be the best method, and benefits will accrue therefrom in many unanticipated directions. J. J. CAGNEY.

Lamps may be marked for identification of sizes by scratching a figure with a sharp awl on lamp top or contact plate. This is very convenient when candle-power tags are lost.

EDISON ILL'G CO. OF WEST CHESTER.

The best way I know of is to mark date on base of lamps when first put on line. A. O. FRETZ.

Have name etched in the glass near the base.

E. A. M., N. Y. ED. CO.

Lamp manufacturers should mark on glass in some way the initials of the central station or customer. We have lamps returned to us that are very difficult to recognize.

F. D. SAMPSON.

S 9. When a company furnishes first installation of incandescent lamps and furnishes renewals, the lamps at all times being

the property of the company, does the value of the lamps on the lines represent a permanent asset, the same as arc lamps, meters, etc., owned by the company?

The lamps on the line certainly represent an asset, the value of which depends upon the number of lamps installed.
EDISON ILL'G CO. OF WEST CHESTER.

If regularly renewed when exhausted they should represent an asset of about 60 per cent of their original cost.
J. J. CAGNEY.

Yes.
ANDREW F. HALL.
E. A. M., N. Y. ED. CO.

Yes; subject to a very high factor of depreciation.
H. A. STRAUSS.

The incandescent lamp has rather too low a second-hand value to justify carrying it as an asset on the balance sheet or ledger. The cost of collecting lamps once installed would probably offset their value. RALPH R. LAXTON.

S 10. Do you find it advisable to loan incandescent lamp clusters free? What is your policy in regard to arc lamps?

Incandescent lamp clusters and arc lamps are furnished free, and remain property of company. E. R. FRENCH.

We believe it pays to furnish arc lamps to customers free, also clusters, where they will be installed for permanent use.
EDISON ILL'G CO. OF WEST CHESTER.

Free clusters have resulted in a handsome increase of business. We also loan arc lamps, and in small stores the results favor the cluster as giving a fixture on which one or more lamps will be used every night, where an arc, on account of its greater cost, would be reserved for Saturdays and special occasions.
PERCY INGALLS.

If I loaned clusters free I would cut out the arc-lamp question. I think clusters are more satisfactory, cheaper to install and maintain, and the investment is not so heavy as with arc lamps.

F. M. VANDER VOORT.

No; owing to the various accessories that may be required, in the shape of extension rods, shades, canopies and finish of metal parts, the practice of loaning incandescent clusters is likely to prove rather expensive.

Arc lamps, on the contrary, being of standard finish and construction, do not meet the above objection and should be furnished free.

E. A. M., N. Y. ED. CO.

We do not loan incandescent lamp clusters free, but we do loan arc lamps free of cost.

LUDWIG KEMPER.

The practice of loaning incandescent lamp clusters could not be countenanced on a large system. For arc lamps we charge regular incandescent rate plus $1.00 per month for rental and attendance on lamps.

J. J. CAGNEY.

We have not yet thought it policy to carry investment in incandescent lamp clusters, furnishing them free to customers, as these devices, as a rule, do not cost very much, and it is no hardship on customers to purchase them, especially as they can be used generally. Our policy in regard to arc lamps is to furnish the lamp, maintain it and keep it trimmed free of charge; though if customers desire to purchase and own the lamps themselves, we have no objection to their doing so.

T. H. T. & L. Co.

We furnish arc lamps and trim them free of cost to customers. All lamps on meter basis.

F. D. SAMPSON.

Arc lamps furnished free.

ANDREW F. HALL.

S 11. If you do not furnish Nernst lamps free, how do you charge for the lamps, and how for the maintenance?

Nernst lamps supplied only in case of regular contract signed by the customer. In such cases lamps are furnished and maintained without cost to the customer.

J. W. C., E. E. I. Co., BOSTON.

We furnish and maintain Nernst lamps free to customers on term contracts. As this class of business has only recently been started, some details have not yet been decided.

DUDLEY FARRAND.

We furnish Nernst lamps free and also maintain them. Think this is wrong. Experience would indicate that the consumer should pay for the lamp and that a charge of $1.00 per month is necessary to cover maintenance and other costs.

JAMES MILNE.

We furnish all Nernst lamps free, and always keep them in repair, they being put out under regular contract with a minimum rate of 30 hours per month at 16 cents; excess current, 4 cents.

E. F. PHILLIPS.

S 12. As a matter of policy, in districts where a meter rate prevails, is it advisable to introduce or encourage the use of osmium, tantalum or other high-efficiency lamps, even when these are to be supplied by the customer?

Yes. Everything should be done to make electricity economical to use. The incandescent mantle did not injure the gas business even temporarily, and was ultimately of inestimable value to it.

J. S. CODMAN.

We believe it is advisable, as a matter of policy, to introduce and encourage the use of any lamp that will enable customers to reduce their bills. By so doing you will always have a satisfied customer, who in turn will secure other customers for you.

T. H. T. & L. Co.

The introduction of almost any novelty, be it a lamp or appliance of any nature, that will serve to popularize electric service while not introducing disturbing or detrimental elements, should be good policy at all times, notwithstanding the fact that the initial consumption may not be very considerable.

J. J. Cagney.

(Practically concurrent opinions expressed by E. A. M., N. Y. Ed. Co., Warren Partridge, C. E. Inman.)

We believe that anything tending to increase efficiency of lamps or similar devices should be encouraged, on the ground that the business resulting will increase both in the aggregate and the income from the unit of capacity installed.

L. W. Emerick.

Yes—on the principle that the cheaper you can sell, the more you will sell. H. A. Strauss.

I think it is good policy to encourage the use of any means that will give the maximum service at the minimum cost or the most conveniences at the same or less price.

S. S. Ingman.

Yes; anything within reason to encourage and extend the use of electric current by competition in price as well as quality of service with other illuminants. It is always good policy to disabuse the public mind of the idea that electricity is "expensive."

Ralph R. Laxton.

Yes, certainly. When consumers learn that they can get twice the amount of light for the same amount of money, or nearly so, they will use enough more light to keep their bills at about the same figure, and the new business gained by advertising cheap light will put the balance on the right side of the ledger. E. A. Vaughan.

Percy Ingalls.

S 13. Should incandescent series street lamps be left in the socket until they burn out, or be replaced at predetermined intervals?

We have an installation of some 3000 series incandescent lamps in one of the plants with which the writer is connected.

We have patrolmen who cover these lamps every night and we leave it to them to determine when a lamp is dim and replace same before burning out. In our experience, lamp breakage covers 50 per cent or more of all renewals, and the writer has known months where it has run as high as 80 per cent; consequently, the percentage of lamps that are left on for a number of hours is very low. The writer thinks that it is much better to replace under any conditions before they burn out, to give proper service. F. C. S., MALDEN ELECTRIC Co.

With the present types of street series incandescent lamps it has been desirable to replace the blackened lamps at periodic intervals to insure a clear lighting service. With the new GEM-filament high-efficiency street series lamps, however, such requirements will not be necessary, as the lamps will not decline below their useful candle-power during their life. F. W. WILLCOX.

We inspect our street lamps every night and replace all dim lamps. LUDWIG KEMPER.

Good street-lighting service can not be maintained unless lamps are replaced as soon as they become sufficiently blackened to attract attention. J. W. C., E. E. I. Co., BOSTON.
J. J. GAFFNEY.
J. L. MOORE.

I should replace the lamp at predetermined intervals and have the change take place before lamp is condemned by the city authorities. Cities, like individuals, appreciate good service.
J. H. ENRIGHT.

Replace all incandescent street lamps as soon as they show too great a loss in candle-power. As a rule, you are only fulfilling your contract in doing this; but aside from that it is a form of advertising. F. TOBEY, JR.

Incandescent street lamps should be renewed before they burn out. Street lighting is a sample of the company's product which every one sees. PERCY INGALLS.

We have tried both methods and find the proper thing to do is to leave the lamp in circuit until it turns black or burns out. Let your inspector renew black lamps in the daytime and burned-out ones at night. E. C. DEAL.

The city electrician or engineer may always be depended upon to call for renewals when lamps become dim. J. J. CAGNEY.

Renew all lamps at predetermined intervals, say every 900 or 1200 hours. If high-efficiency lamps are used, with good regulation they will burn out before they depreciate very much in candle-power. BEACON LIGHT CO.

S 14. With a plant containing direct-connected units, 200-kilowatt capacity, coal $2.35, what should be the cost each, per month, for 12 series alternating street lights, 450-watt arc lamps?

With a simple automatic high-speed engine, 200-kilowatt capacity, operating but twelve 450-watt arc lamps, the engine is operating at a very inefficient load—50 per cent or less—and will require 12 to 15 pounds of coal per kilowatt-hour; make it 13 pounds and it will require $2.55 per lamp, per month, for fuel to operate these lamps on the basis of 4000 lamp-hours per year, at the price you quote for coal and 65 cents per lamp per month for oil, waste, carbons, globes, repairs, interest and depreciation, making a total of $3.20. What other charges should be added depends on the conditions this service would create in the operation of the plant. If this set, engine and dynamo, should have to run on other service, or could be utilized for other service at the same time, so as to improve the load factor, the conditions would be altered just that much. S. S. INGMAN.

With coal at $2.35 per ton, $60 per year will cover the cost of burning and maintaining one 450-watt lamp, twelve hours per day for one year. Sixty dollars is the cost, and must not be accepted in any sense as a commercial rate. The selling rate would necessarily vary with installation cost of lines, apparatus, and so forth. W. W. FULLER.

S 15. What height above the street level do you consider ost satisfactory for incandescent lamps in suburban districts eavily shaded by trees?

Twelve feet. The writer does not know of a fixture at the
esent time on the market that will compare in artistic appear-
ice with the post fixture used for gas or vapor mantle lamps,
r the reason that the only proper method of incandescent light-
g for streets requires that the lights should not be less than four
five feet out into the street. I think the electric people are the
ily ones who have taken advantage of this better method of
ghting, consequently the design of the fixture has never met
e straight-post fixture of the incandescent gas lamp.

F. C. S., Malden Electric Co.

Twelve feet. If trees interfere at this height they can
ually be trimmed out. Beacon Light Co.

Twelve to 14 feet, and lengthen the fixtures to compensate
r bushy shade-trees. F. M. Vander Voort.

Twelve to 15 feet. J. L. Moore.

Our practice is from 13 to 15 feet, according to conditions.

J. W. C., E. E. I. Co., Boston.

Usually the safety of the lamp and fixture would require
at it be placed 14 and 15 feet from the ground, and that is high
iough for illumination. F. Tobey, Jr.

Fifteen feet. F. Ellwood Smith.

E. R. French.

For 25-cp series lamps 15 feet clear from street.

H. E. Ryder.

Sixteen feet gives satisfactory results; where necessary, drop
wn to 14 feet. W. W. Fuller.

From 15 to 18 feet. J. J. Cagney.

Eighteen feet, if possible; if not, 16 feet.
ANDREW F. HALL.

Twenty to 22 feet. L. W. GREENE.

S 16. Has anything been done to give the fixtures used for incandescent street lighting a more artistic appearance so that they will compare favorably with the best fixtures used for gas or vapor mantle lamps?

Have recently undertaken the problem and are now working up several styles of new fixtures with the idea of improving the artistic appearance of our street-lighting system.
J. W. C., E. E. I. Co., BOSTON.

There are several neat and strong street fixtures on the market, which can be bought for a very reasonable price.
BEACON LIGHT CO.
J. J. CAGNEY.

S 17. Where series arc lamps are installed on mast-arms using Cutter pulleys, what has proved the best method of securing the end of the rope to prevent meddlers from releasing the lamp?

Replace the lamps up to the required height, then cut the rope or chain off about six feet above the ground; that is, cut off the part now used for tying and lowering purposes. Make up a ring or link in end of rope or chain, then bolt a catch or substantial hook to side of pole, the required height, for fastening purposes.

This method will be found the most satisfactory remedy for breaking up or discouraging meddlers; in addition, it will save one-half the cost of rope renewals, and about one-half the time required to lower and raise lamps when trimming. Of course, trimmers must carry a short lowering rope with a snap-hook on end. Replace ropes with chain. W. W. FULLER.

Fletcher lock windlass will prevent lamp from coming down.
ANDREW F. HALL.

Fasten to a cleat, to be reached only by a short ladder or rom a wagon. F. TOBEY, JR.

A small self-acting lock arrangement seems most feasible.
J. J. CAGNEY.

Cutter's pole lock is a satisfactory device, and it should be ›cated not less than eight feet from the ground to prevent passrs-by from handling it without making a special effort to do ›.
F. M. VANDER VOORT.

The lock used with the Philbrook mast-arm has proved very atisfactory.
F. ELLWOOD SMITH.
J. W. C., E. E. I. Co., BOSTON.

By using Cutter patent pulleys, the lamps remain suspended ven if rope is released. We raise the rope on pole eight or nine eet and fasten 1.5-inch ring in end to slip over lag-bolt and nable trimmer to hook hand-line. W. D. JENNINGS.

Take a rope thimble, make up on the end of the rope a long ye-bolt, flattened so the thimble will go over the eye, drive the olt into the pole and put a good brass lock in the eye. You an get of your hardware man four or five dozen locks with a ozen keys, one of which will fit all of the locks. That is the best nethod I have found. L. W. GREENE.

S 18. What particular method of suspending and insulating series commercial arc lamp and the service wires to it, secures he greatest protection from accidents and damages caused by ain and wind?

We use a high-voltage insulator between the hanger-board nd the arc-lamp cable that supports the lamp. Wires that run o the lamp run directly from glass insulators to the spreader on he arc-lamp hanger-board. We have had no trouble with this nethod of suspension when same has been properly installed. Ve have used most entirely the Cutter high-voltage insulator for number of years and have had no trouble thus far with same.
F. C. S., MALDEN ELECTRIC CO.

In this city we have fifty-one arc lamps suspended in the manner illustrated in Figure 1. A guy-wire is stretched diagonally across the street-corner and the lamp is hung in the centre of the crossing by an insulating hanger. This hanger removes the strain of the wires from the binding-posts of the lamp and gives ample insulation from the ground, even in the worst sleet storms. The fact that lamps are not lowered for trimming makes the wires less likely to break. In six years we have not had a wire break at a lamp that was suspended in this manner.

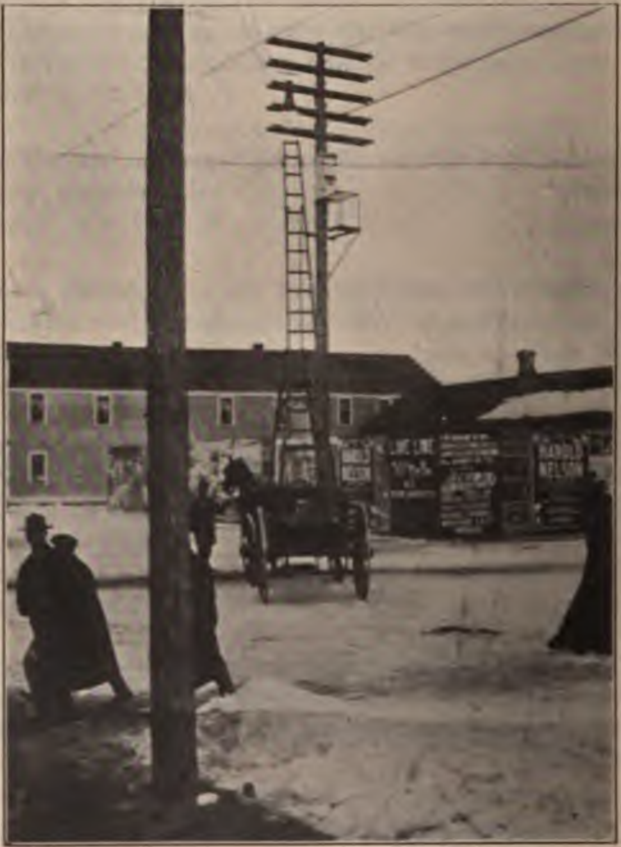


FIG. 1—ARC LAMPS HUNG WITHOUT LOWERING DEVICE

Our method of trimming is something novel, we believe. At least our tower-wagon is. We use the rig illustrated in Figures 2 and 3. This wagon was designed and built here in our shop. We believe that this system of trimming has the following advantages over the drop-hanger method:

1st—It is cheaper, because we save the cost and maintenance of so many hangers.

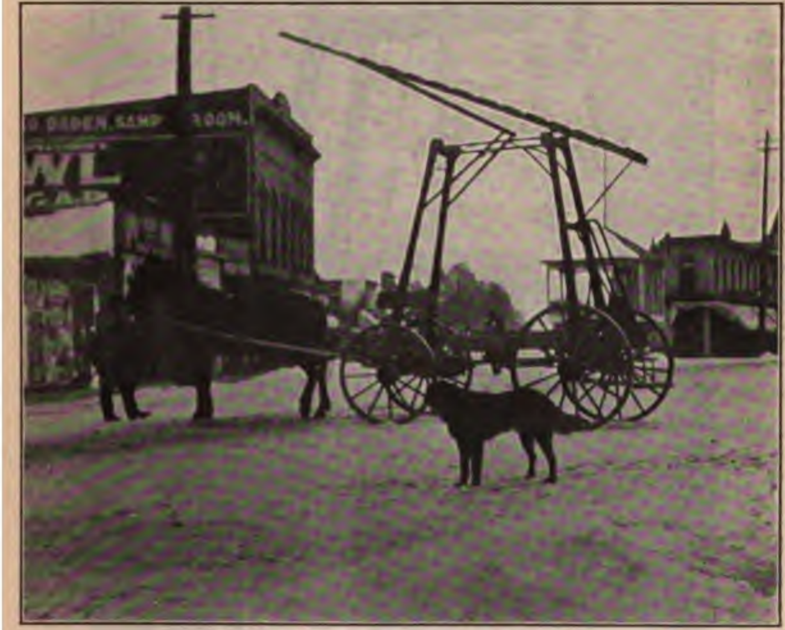


FIG. 2—LAMP TRIMMER'S TOWER-WAGON

2nd—Quicker. The writer has traveled ten miles and trimmed fifty enclosed arc lamps in four and one-half hours.

3rd—Safer. If a lamp must be handled when the current is on, the ladder is ample insulation for the trimmer; no wires break and there is nothing within reach of meddlers.

A. G. FULTON.

A substantial crane with wires carried through the pipe-arm has proved very durable with us.

J. W. C., E. E. I. Co., BOSTON.

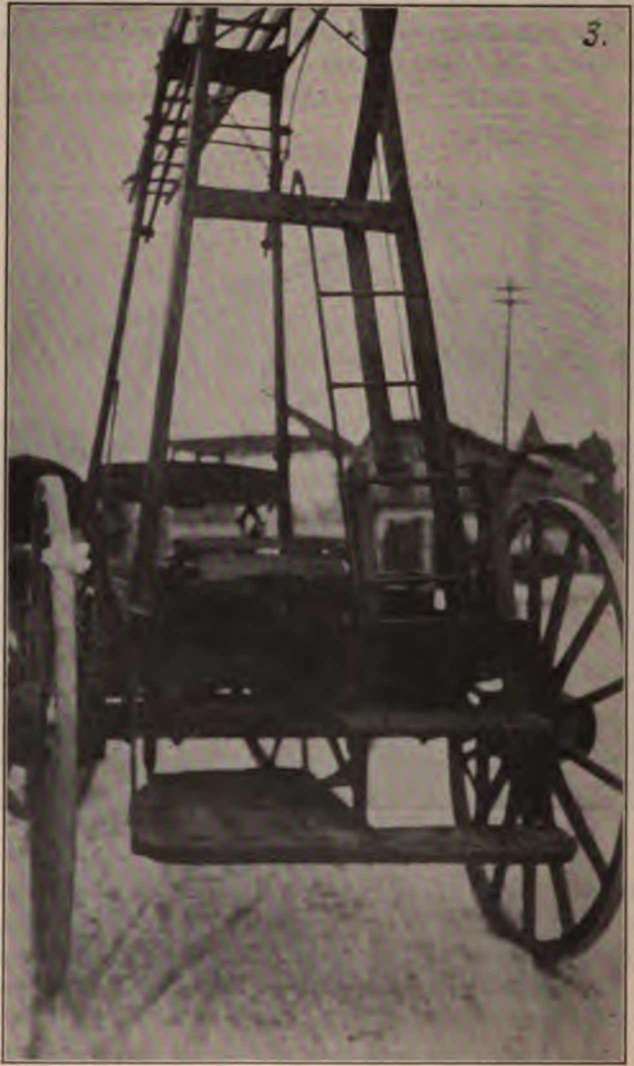


Fig. 3—Lamp Trimmer's Tower-Wagon (Rear View)

Absolute cutouts on all lamps. Where line is opened for lamp loop, cast-iron breaker-arms should be used with flat duplex rubber-covered cable connected to cutouts by McIntire sleeves.
W. D. JENNINGS.

S 19. What is the best insulator to use as a break knob on commercial series arc lamps in the suspension?

Cutter's high-voltage porcelain insulator.
W. D. JENNINGS.
J. W. C., E. E. I. Co., BOSTON.

S 20. What is the best insulator to use on a T-iron to support the leading-in and leading-out wires to a series commercial arc lamp?

S 21. Does the placing of spark gaps across series arc lamp terminals absolutely prevent the burning out of lamp coils during lightning storms?

Probably not absolutely, but the number of burnouts without spark gaps would be materially increased. W. D. JENNINGS.

It would be too much to say that anything absolutely prevents burnouts from lightning. I should prefer individual arresters well grounded to a spark gap across lamp terminals.
RALPH R. LAXTON.

S 22. What actual life per trim is being obtained from the different types of alternating and direct-current series enclosed-arc lamps? State maker; alternating or direct current; amperes; length and size of carbons; average number of carbons per trim.

We average 78 hours 6.6 ampere General Electric alternating lines, carbons 9-inch by 0.5-inch. One upper carbon makes lower for next trim. ANDREW F. HALL.

About 90 to 95 hours on Westinghouse 7.5-ampere series arc lamps, 0.5-inch by 10-inch carbons. R. N. KIMBALL.

We use General Electric series alternating, 6.6-ampere arc lamps, but run them at seven amperes. We have no trouble getting 100 hours' life from 0.5-inch by 12-inch carbons. We are using 170 of these lamps for street lighting. W. H. FELLOWS.

With General Electric 5-ampere series enclosed-arc lamps, we are getting an average life per trim of 80 hours. Carbons are 12-inch by 0.5-inch. UNITED ELEC. LT. CO.

Ninety to 95 hours from 0.5-inch by 9.5-inch carbons in General Electric 66-cycle arcs on series circuit.

F. M. VANDER VOORT.

We get 60 hours per trim. Lamps are General Electric alternating series enclosed, 6.6-ampere, carbons 0.5-inch by 9.5-inch. W. W. FULLER.

We are using General Electric constant-current, 6.6-ampere series arcs on streets. The average life is about 84 hours, but we have reached as high as 92 hours per trim without trouble.

THE COLORADO SPRINGS ELEC. CO.

One hundred and ten hours, with Westinghouse alternating series, 60-cycle, 6.6-ampere, 12-inch lower, 7-inch upper, 0.5-inch diameter. L. W. GREENE.

General Electric, form 6, 6.6-ampere, series alternating-current, with No. 29-A inner globe, No. 8 outer globe, open-base, Electra carbons; upper, 0.5-inch by 12-inch; lower, 0.5-inch by 6-inch. Average longest burning for total number of lamps, 91 hours. Trim lamps regularly once per week. Waste slight compared to advantages. One 12-inch carbon per trim.

F. D. SAMPSON.

One hundred and twenty-five hours for the direct-current, 6.6-ampere 12-inch by 0.5-inch carbon G. E. lamp; 100 hours for the alternating-current 6.6-ampere 12-inch by 0.5-inch carbon G. E. lamp. J. W. C., E. E. I. CO., BOSTON.

General Electric alternating-current, 6.6-ampere, 9.5-inch by 0.5-inch carbons. Actual life: minimum, 78 hours; maximum, 83 hours. W. D. JENNINGS.

We use the G. E. alternating-current 7.5-ampere, enclosed-arc lamps. Average life of carbons is 119 hours. Carbons measure 12 inches by 0.55 inch. Columbia carbons.
J. J. GAFFNEY.

S 23. (a) What is the average breakage of inner globes? (b) What is the minimum?

Our average breakage for 400 lamps last year was 10.5 per cent per month. W. H. FELLOWS.

We average for 4000-hour service, five inner globes per lamp. UNITED ELEC. LT. CO.

(a) 2925 hours. (b) 2250 hours. J. J. GAFFNEY.

Two globes per lamp per year. A. O. FRETZ.

Twenty-five per cent. ANDREW F. HALL.

In our case (a) three globes per annum. (b) Two globes per annum. We have one Fostoria light opal, that has burned 5130 hours, but it is a "freak." F. D. SAMPSON.

Two and one-half inner globes per lamp per year is a fair average. One and one-half inner globes per lamp per year, a minimum figure for usually favorable conditions.
J. W. C., E. E. I. CO., BOSTON.

(a) Average breakage, three and one-half; (b) minimum breakage, three. W. D. JENNINGS.

S 24. What is the power factor of the various systems of (a) alternating-current arc lamps (series); (b) of constant-current regulators; (c) of complete systems of various makes?

A station load limited to alternating-current arc lamps will show average power factor of about 70 per cent.

H. A. STRAUSS.

Eighty-four per cent as power factor for the lamps.

J. W. C., E. E. I. Co., BOSTON.

S 25. What success have you had with the flaming arc compared with open and enclosed arcs?

Owing to the excessive first cost of flaming arc lamps and the short life and great cost of the carbons as well as instruction by the insurance authorities to install them for outside use only; aside from the aversion of first-class establishment to the use of such glaring light, the flaming arc has met with small permanent success. E. A. M., N. Y. ED. Co.

S 26. Do you find the arc lamp as popular as formerly in pushing new business? Is your percentage of growth or the number of arc lamps connected as great as of incandescent lamps?

The arc lamp is undoubtedly a great producer of new business, particularly for outside illumination, as it leads up to additional equipments inside later on. The number of arc lamps connected does not equal that of incandescents, owing to the broader field enjoyed by the latter. E. A. M., N. Y. ED. Co.

Our arc load is about one-fifth of our total lighting load. About five years ago it was about half and half.

W. H. FELLOWS.

Meridian and Nernst lamps are taking the place of arc lamps to a large extent. E. R. FRENCH.

I would not push the arc lamps at all, as better illumination can be obtained from high-efficiency incandescents, Nernst lamps or clusters. The light is steadier, and goods examined appear as they will at the purchaser's home. F. M. VANDER VOORT.

No. The cost of current on a meter basis for arc lamps is rather high and the appreciation of this fact on the part of customers inclines them to prefer some means of lighting that will enable them to keep their bills within smaller limits, even though the actual efficiency of the lamps may not be as good as that of the arc. L. W. EMERICK.

The commercial arc lamp is now and will probably always be a commanding factor in the illuminating field. While it is not so extensively used as formerly, due to increased window illumination by incandescent lamps for artistic and decorative effects, inside and outside Nernst lamps, inside high-efficiency lamps and illuminated signs—our records indicate a continued growth. The percentage of increase is 2.6 per cent; much less than that of incandescent lamps.

THE BROOKLYN EDISON, E. W. PHILLIPS.

No. Metalized-filament lamps, Meridian lamps and Nernst lamps are deservedly popular for interior illumination.

W. D. JENNINGS.

There are so many devices more ornamental and susceptible of more artistic and effective distribution than the arc lamp that I think its use as an interior illuminant will be somewhat restricted. RALPH R. LAXTON.

No. G. H. CUSHMAN.

***S 27. Is the electric-arc or the gas-arc lamp better for discerning colors?**

The electric-arc light, properly corrected, is superior to the gas-arc light for discerning colors. E. A. M., N. Y. ED. CO.

The electric arc has a decided advantage in this respect. The enclosed electric arc with clear globes is rather blue for the best color selection. By the use of proper enclosing globes and diffusing shades coated with material having a high selective absorption for violet, the color can be corrected to a degree of whiteness that can not be approached by the gas arc, which ranges from greenish-white to greenish-yellow in color, depending upon the make and age of the mantles.

An object can not appear whiter than the light which falls upon it. Therefore so-called white materials appear as pale green or greenish-yellow under gas arcs, and it is very difficult to distinguish whites from pale greens or greenish-yellows or to differentiate between shades of this class differing slightly from each other. Blues and violets suffer to the greatest extent under the gas arc.

There appears to be more or less misunderstanding as to what is meant by "white light" and we frequently observe daylight and sunlight confused. Sunlight, before it enters the earth's atmosphere, is white. Light waves are scattered inversely as the sixth power of the wave length, therefore the short blue and violet waves are separated by particles of moisture, smoke or dust suspended in the atmosphere, thus producing the blue sky. With the short waves separated the sun appears more or less yellow, changing from orange to even red under certain conditions of haze and smoke, particularly when the light passes through approximately 32 atmospheres just after rising or before disappearing below the horizon.

Yellow lights are occasionally referred to as possessing daylight qualities because they are of sunlight color. We do not, however, use yellow sunlight direct. The diffused blue skylight combines with the direct light of the sun and forms daylight, that is, the re-united white light, hence arises the misconception referred to. W. D'A. RYAN.

For almost all classes of work where it is desired to get the same effect from colored goods as by daylight, the electric arc is by far preferable to the gas-arc lamp, as the gas-arc lamp, even with the modern yellowish-white mantel, has nevertheless a distinctly greenish tinge. It is desirable, however, always to select the colored goods in a light the same as that under which they are to be used. For example, when buying a piece goods for evening wear, where the chances are strong that it ill be used under incandescent light, such goods should be lected in a room lighted by incandescent lights and not in a om lighted by daylight, arc light, or any other kind, as the lor value of the same may be entirely altered by the color of e light under which it is used.

VAN RENSSELAER LANSINGH.

The electric arc is the better. Try it especially on patterns ith white backgrounds. Look at shades of blue and orange in ıylight and then compare at night with gas-arc and electric arc.

F. D. SAMPSON.

The electric arc. J. W. C., E. E. I. Co., BOSTON.

W. D. JENNINGS.

We find the gas-arc better than the alternating enclosed arc r discerning colors. W. H. FELLOWS.

S 28. What candle-power of incandescent street lamp is the ost advantageous from an operating standpoint?

The 25-cp lamp is a good standard and is of best advantage om an operating and extension point of view.

C. C. GARTLAND.

We use 25-cp lamps for street lighting. Have over 1000 on ır circuits. E. R. FRENCH.

Twenty-five candle-power. F. ELLWOOD SMITH.

Thirty-two candle-power. J. W. C., E. E. I. Co., BOSTON.

S 29. Has any one of the various candle-powers of incan- scent lamps used for street lighting predominance enough to be ılled standard?

We always advise to use 32-cp lamps when arc lamps are ɔt wanted. We consider 16-cp lamps too small to give satisfac- ıry street light. LUDWIG KEMPER.

From information obtained, I should judge that the 25-cp lamp predominates, but could hardly be called standard. The writer thinks that the 50-cp lamp would be a better standard to use. F. C. S., MALDEN ELECTRIC CO.

The demand occurs principally for lamps of 25, 30, 40 and 50 candle-power, with a majority of 25 candle-power.

F. W. WILLCOX.

Unfortunately, no. J. W. C., E. E. I. Co., BOSTON.

S 30. What is the best 2000-cp arc lamp suitable for a direct-current series arc system for street lighting using a Western Electric arc dynamo (60-lt) which can be adjusted to from 7 to 10 amperes?

Double-carbon Brush arc lamp. W. D. JENNINGS.

Thomson-Houston open-arc lamp. G. H. CUSHMAN.

S 31. Where the voltage variation ranges from 90 to 115 (largest variation in daytime), what lamp would you recommend for general use as regards wattage and voltage? Meter system is used.

You have no right to permit a variation in voltage of 90 to 115. You should install a voltage regulator; then adopt the most economical lamp your system can use. Both the Tirrill regulator, made by the General Electric Company, and the Belknap, made by the Portland Company, are instruments capable of regulating to within two per cent. You will then be able to adopt any voltage within your range that you find the most suitable, and a 3.5-watt lamp will be found very satisfactory.

J. R. COX.

Use 3.5-watt lamps of voltage slightly lower than the aver-
ge line voltage, between 5 and 10 p. m., when most lights are in
se. WARREN PARTRIDGE.

One hundred and twelve volts, 3.5 watts per candle-power.
should recommend something to be done to improve the voltage.
he writer thinks this entirely uncalled for.
F. C. S., MALDEN ELECTRIC CO.

I would recommend more copper in line and some voltage
gulators on machines and feeders. F. W. WILLCOX.

Use 115-volt, 3.5-watt lamp; you will get better life and per-
rmance. You couldn't use a higher efficiency lamp with varia-
on as mentioned, and a lower one would be rather bad upon
ur customer in two ways—his bills would be increased and his
ht would be no better. Can't you regulate a bit better?
F. D. SAMPSON.

The 64-watt lamp at 105 volts. H. A. STRAUSS.

Such excessive range of voltage as noted would prevent
y kind of good service. Better improve the regulation than
talk about voltage or wattage of lamps.
J. W. C., E. E. I. Co., BOSTON.

Use a lamp of 3.5 watts per candle-power and of voltage that
nearest to the voltage at maximum load. In connection with
e above question I would recommend the installing of an auto-
atic voltage regulator. F. W. BULLOCK.

If impossible to correct the variation in voltage, use lamps of
ltage as near as possible to the average voltage maintained
ring the hours when the lamp load is heaviest. 3.5-watt lamps
ith free renewals would seem fairest to your meter customers.
RALPH R. LAXTON.

S 32. In what proportion does increase or decrease in voltage of circuit over or under that of lamps in service effect consumption?

The variation in life of lamps and average consumption with increase and decrease in voltage, is given in the attached table:

TABLE SHOWING VARIATION IN LIFE WITH VARIATION IN VOLTAGE AND CORRESPONDING VARIATION IN AMPERES, OHMS, WATTS AND WATTS PER CANDLE

Per Cent Volts	Per Cent Life	Per Cent C.P.	Per Cent Amperes	Per Cent Ohms	Per Cent Watts	Per Cent W.P.C.
112.3	10	187.8	112.6	99.77	126.5	67.3
108.4	20	155.7	108.6	99.84	117.7	75.5
106.2	30	139.1	106.3	99.89	112.8	81.5
104.7	40	128.6	104.2	99.92	109.6	85.3
103.5	50	121.0	103.5	99.94	107.2	88.6
102.6	60	115.1	102.6	99.955	105.3	91.5
101.8	70	110.2	101.8	99.97	103.6	94.0
101.2	80	106.4	101.2	99.98	102.3	96.1
100.5	90	102.9	100.5	99.99	101.0	98.3
100.0	100	100.0	100.0	100.00	100.0	100.0
99.5	110	97.4	99.5	100.0075	99.0	101.8
99.1	120	95.2	99.1	100.015	98.2	103.3
98.8	130	93.1	98.7	100.02	97.4	104.7
98.4	140	91.2	98.3	100.0275	96.7	106.1
98.1	150	89.6	98.0	100.0325	96.0	107.3
97.8	160	88.0	97.7	100.0375	95.4	108.5
97.5	170	86.6	97.4	100.0425	94.8	109.6
97.2	180	85.1	97.1	100.0475	94.3	110.8
96.9	190	83.7	96.8	100.0525	93.7	112.0
96.6	200	82.5	96.5	100.055	93.2	113.3

F. W. Willcox.

S 33. What is the actual life of 16-cp, 3.5-watt and 3.1-watt lamps used on metered systems with a connected load of from 5000 to 10,000 lamps?

Using 3.5-watt lamps on a metered system, and having followed the policy of giving lamp renewals to all meter customers, since January 1, 1905, we find that the actual life of lamps renewed ranges between 750 and 900 lamp-hours. We have about 9000 lamps connected load. Bristol Gas and Elec. Co.

No lamp will work economically over 1000 hours, and the average life is more in the neighborhood of 600 hours.

E. A. M., N. Y. Ed. Co.

With careful test made at exactly normal voltage, it will be found that the average life of the present 16-cp, 100-130-volt, 3.1-w.p.c. lamp is approximately 800 hours, and the 16-cp, 3.5-w.p.c. 110-130-volt lamps about 1500 hours. F. W. WILLCOX.

S 34. Will it shorten the life of an ordinary incandescent lamp to burn two in series on a circuit, the voltage of which is twice that of a single lamp?

It should not shorten the life, provided the lamps are selected for uniform amperage and the sum of the volts of the two lamps equals the voltage of the circuit. F. W. WILLCOX.

S 35. What are the weak points of renewed lamps? Do they usually have a long life? Do they lose their candle-power rapidly?

S 36. A 16-cp, 110-volt lamp that was turned off, suddenly exploded. Can you give a cause for the explosion?

S 37. What are your rules governing the first installation and renewal of incandescent lamps?

The first installation of lamps is furnished free and 20 per cent additional for renewals. E. A. M., N. Y. ED. CO.

We supply the first installation of lamps and renew same free of charge. This includes Meridian lamps, as well as common lamps. UNITED ELEC. LT. CO.

We furnish first installation and renewals and insist on not letting them burn too long. A black lamp is very unsightly and wasteful. WALTER FLINT.

Sell first installation of lamps at 200-lot price each. Renew free of cost upon presentation of burned-out or blackened lamps.
F. D. SAMPSON.

The first installation of incandescent lamps paid for by consumer, and renewals furnished free by company on return of unbroken, burned-out lamps, or unbroken lamps badly blackened by service. T. H. T. & L. CO.

Our company charges for the first installation of lamps at the rate of 25 cents per lamp for standard 16-cp lamps, and then renews the lamps free as long as the meter is kept in use.

BRISTOL GAS AND ELECTRIC CO.

Customers pay first installation; we furnish renewals.

H. D. LARRABEE.
A. R. MACKINNON.
A. PETERS.

S 38. What is the cost of operation of the Cooper Hewitt lamp as compared with that of incandescent arc lighting?

Cooper Hewitt lamp, type K, 45 inches long, for 3.5 amperes direct current, 700-cp perpendicular to tube, or 575-cp mean hemispherical, without reflector, and 1200-cp mean hemispherical with reflector, consumes 364 watts on 104-volt circuit and 385 watts on 110-volt circuit. Tube guaranteed 4300 hours, but not to exceed one year. Cost of maintenance and labor, *i. e.,* tube and labor of exchanging tube, is $12 per year. Cost of current in this time at five cents per kilowatt-hour for 4300 hours is $78.26.

Therefore combined current and maintenance cost per candle-power per year =

$$\frac{\$78.26+\$12}{575} = 15.6 \text{ cents or } \frac{\$78.26+\$12}{1200} = 7.5 \text{ cents.}$$

For smaller direct-current lamps and alternating-current lamps, ratios are about in proportion.

Incandescent arc lighting (enclosed arc) 5-ampere, direct-current, mean hemispherical candle-power 260, with opalescent inner and no outer globe, average watts 413 for series circuit and 520 for multiple circuit (104 volts), (see *Electrical World,* February 17, 1906), test made by electrical testing laboratories, city cost of maintenance, labor, *et cætera,* with 150 hours retrimming = $5.16 per year. Cost for current for this time, 4300 hours at 5 cents per kilowatt-hour = $88.80 for series running and \$111.80 for multiple running; therefore, combined current and maintenance cost per year per candle-power =

$$\frac{\$88.80 + \$5.16}{260} = 36.1 \text{ cents or } \frac{\$111.80 + \$5.16}{260} = 45 \text{ cents.}$$

Therefore, it costs about three to six times, or two and one-half to five times, as much to run an enclosed arc as it does to operate a Cooper Hewitt lamp for the same light, varying with the conditions. PERCY H. THOMAS.

Lamp for lamp, the current consumption is about equal. The cost of Cooper Hewitt renewals, however, places the operating cost far above that of the enclosed-arc lamp.

E. A. M., N. Y. ED. CO.

S 39. Have mercury arc rectifiers proved satisfactory on series arc circuits?

I understand not. A. PETERS.

Mercury vapor converters can be used satisfactorily for operating series direct-current arc lamps, but up to the present time the data on such circuits in commercial operation is meagre.

PERCY H. THOMAS.

Mercury arc rectifiers are proving very satisfactory on arc circuits. The large installation in Portland, Ore., is a good example. CHAS. W. STONE.

They have at four amperes, but we have heard of no cases of larger amperage. W. D. JENNINGS.

S 40. What is the quality of the light of arc lamps supplied by mercury arc rectifier as compared with that of lamps supplied by constant-current generators?

The quality of the light from direct-current lamps supplied from mercury vapor converters is good if the controlling apparatus is properly designed. The operation of such direct-current arc lamps is very much superior as regards flicker to that from 25-cycle alternating-current arcs. PERCY H. THOMAS.

Assuming the same arc lamps in both cases there is no choice. W. D. JENNINGS.

From a theoretical point of view it would seem that the lamps supplied with current from constant-current generators should have a slight advantage in volume of light over lamps supplied with rectified current, particularly at low frequency. If any difference exists, however, it is within the range of photometric accuracy and not within the range of visual detection, from experiments to date. W. D'A. RYAN.

S 41. Describe any system of flaming arcs, giving characteristics peculiar to a system of this kind.

The term "flame arc" is applied to a number of foreign lamps of the open-arc type operated with small impregnated carbons, generally arranged so as to draw a horizontal arc. During the past three years a number of tests have been conducted on these so-called flame-arc lamps and electrodes, including Blondel, Siemens, Excello, Conradty, Bremer and Electra.

Under laboratory conditions, when operated without globes, the efficiency of these electrodes runs anywhere from 0.25 to 0.5 watt per mean spherical candle-power. In order to cut down the intrinsic brilliancy and improve the distribution, it is customary to operate with opal globes. This, however, greatly reduces the light, due possibly to high selective absorption of the glass for yellow rays and partial exclusion of air from the arc, and to some extent total reflection on the inside of the globe due to high location of the arc. When operated two in series on 110-volt circuits, under practical conditions, including steadying resistance, the efficiencies varied 0.5 to 0.9 watt per mean spherical candle-power for the electrodes giving yellow light.

It was found with the red flame electrodes the light was reduced about 25 per cent and with the white electrodes about 50 per cent.

The weak points of the flame arcs in their present form are high maintenance cost—due to expensive short-life electrodes—high intrinsic globe brilliancy, unsteadiness, fumes and poor distribution. For obvious reasons, the light is not suited for indoor lighting and the distribution is not proper for street illumination. At the present time it appears to be mostly used for spectacular or advertising purposes. I do not think that this lamp can be regarded as a permanent advance in the art, particularly for American practice. Foreign practice is no criterion. It will be just as difficult to introduce short-life lamps having high maintenance cost in this country, where carbons and labor are high and the cost of current relatively low, as it is to introduce the enclosed-arc lamp in Europe, where the cost of carbons and labor is low and current relatively high.

While the question of efficiency is of great importance, we should consider that we have passed through the experience of replacing thousands of open-arc lamps by enclosed-arc lamps, giving about one-half the light, but having the advantage of better distribution and the long-burning feature. Any change in lighting apparatus, to be successful in the American market, must possess these fundamental advantages irrespective of the question of efficiency. W. D'A. RYAN.

S 42. Is the flaming arc lamp making any material inroads on standard enclosed-arc lamp business?

No; the lamps installed thus far have been more in the nature of novelties than for any practical use.

E. A. M., N. Y. ED. CO.

S 43. What should be the renewal, from all causes, of globes per lamp per year on series open street arcs using best globes obtainable?

Two globes where you use clear glass. Three when opalescent. The latter burn and become almost opaque when limited to two globes per year, even when thoroughly washed.

F. D. SAMPSON.

One-half globe per lamp per year; an average easily obtainable. J. W. C., E. E. I. Co., BOSTON.

S 44. We run a 440-volt line about one-half mile for supplying four street lights. Four 110-volt lamps in series. A record for

two years shows the lamp farthest away from the station burns out first, five to one. Why?

A pure coincidence, unless due to local conditions surrounding the last lamp. J. W. C., E. E. I. Co., BOSTON.

Wire touching trees or defective insulators between first and third lamps. This would shunt a portion of the current, throwing additional pressure on the fourth lamp.

BEACON LIGHT CO.

To me, the most probable cause seems to be the existence of slight ground on the line between generator and first lamp and the other between third and fourth lamp. W. H. WOLVEKAMP.

With four incandescent lamps in series, the total resistance of the line fixes the current flowing when 440 volts are impressed. "Five to one," the fourth lamp has by chance had the highest resistance, therefore more voltage than it should normally take.

W. D. JENNINGS.

S 45. In connection with a single-phase electric railway it is proposed to do a lighting business. Is incandescent lighting satisfactory at 25 cycles, and, since arc lighting is not satisfactory at this frequency, can Nernst lamps be used with good results?

The operation of the Nernst lamp on twenty-five cycles is the same as on sixty cycles with the exception of the glower life, which is reduced to 400 hours average. E. R. ROBERTS.

Low-voltage incandescent lamps, with consequent bulkier filaments, will not show current reversals as perceptibly as the higher-voltage lamp, although working under one will quickly fatigue the eye. The Nernst lamp, with its even larger mass in the glower, should give better results.

E. A. M., N. Y. ED. CO.

Incandescent lighting at 25 cycles is generally satisfactory, provided the regulation is good and lamps are always maintained at full pressure. Should expect that the fluctuation in voltage due to a railway system would result in lamps being brought below normal voltage a considerable portion of the time, under which conditions the low frequency would probably be noticeable. J. W. C., E. E. I. Co., BOSTON.

Incandescent lighting with 25 cycles has proven satisfactory in Buffalo and other places.

It does not work well on high-economy lamps, due to the filament being so fine it will not retain the heat throughout an entire cycle, but cools off on the low points of the current wave. This causes the light to flicker. The Brooklyn Edison Company has a customer using 180 one-glower, 14 four-glower and 73 three-glower Nernst lamps operating on 25 cycles. The lamps burn perfectly steady and are giving good results. In general, I would say that the maintenance seems to be the same on 25 cycles as on 60 cycles. THE BROOKLYN EDISON, T. N. HICKS.

S 46. What is the cost per kilowatt-hour for care and maintenance of Nernst lamps?

For central-station work from 0.3 to 0.6 cent per kilowatt-hour, depending on quantity in use and local conditions, such as rate of labor and so forth. E. R. ROBERTS.

We have kept careful record of our service where Nernst lamp comprises the customer's entire service, and from it we find the cost of maintenance, including glower, renewals, ballasts, and, in fact, the entire care and maintenance of the lamp, to be one-half cent per kilowatt-hour. E. F. PHILLIPS.

Five-tenths to six-tenths cent per kilowatt-hour.
J. W. C., E. E. I. Co., BOSTON.

S 47. What should be the percentage of depreciation charged against Nernst lamps?

The same as that charged for arc lamps. E. R. ROBERTS.

Twenty per cent plus regular maintenance.
J. W. C., E. E. I. Co., BOSTON.

T—HEATING, BATTERY CHARGING AND POWER

T 1. What is the best way of introducing heating appliances?

This company undertook the introduction of electric cooking and heating apparatus on its system in October, 1905, beginning with daily-paper advertisements followed by personal letters with illustrated descriptive literature. An exhibition and demonstration bureau were established, and neat cards of invitation to attend demonstrations on fixed dates were mailed to each current consumer.

In the meantime a woman canvasser, assisting a specialist in the outside work, was visiting the better classes of residential customers with samples of the smaller devices, encouraging attendance at demonstrations, and taking orders for delivery on sale or consignment. Three employees have been engaged in this work, one inside and two outside, and our records show that 244 pieces, aggregating 78-kilowatt capacity, have been sold and connected to the system during this period.
THE BROOKLYN EDISON, E. W. PHILLIPS.

We think the best way of introducing heating appliances is to send a lady demonstrator to the houses with the goods and let the people have them on two weeks' trial. We are doing this successfully. W. E. H.

Put flat-irons out on trial. If they stay, tell the customer there are other devices just as good. PERCY INGALLS.

House-to-house canvass among selected customers and goods left on trial, especially a flat-iron. E. R. FRENCH.

I think that the only way a central station can introduce heating appliances is to deliver appliances to the customer on 30 or 60 days' trial free. If customers do not retain the apparatus after this use, the writer thinks they will never consider using same. F. C. S., MALDEN ELECTRIC CO.

Placing devices on trial through the medium of a practica canvasser, who shall personally see the device installed.

C. D. W., N. Y. ED. CO.
JAMES I. AYER.
B. J. DENMAN.

This subject, of course, can not be covered by giving any particular way of introducing the devices. The apparatus, conditions, *et cætera,* all have a direct bearing. One of the best ways of introducing electric flat-irons is to put them out on 30 days' free trial, because the average individual is entirely unfamiliar with the electric flat-iron and does not know how valuable and how desirable a device it is. The average user will tell you that he would not be willing to part with a flat-iron at any price if he could not obtain another. They are satisfactory in every way, are economical to operate, *et cætera,* so that it seems that the most important point is to bring their advantages directly to prospective customers. The quickest and the best way is undoubtedly to put them out on free trial with the understanding that they are to be purchased at a certain price or returned. There should be no further conditions at the time of placing them. Many of the devices must be sold outright and introduced through the medium of solicitors who understand their business, in the same manner as you would introduce power motors, electric signs or any other current-consuming device or apparatus. To bring about these results you must first get your prospective customer's attention by putting out printed matter or something of that kind, say with the monthly invoices. You can then arouse his interest by showing how desirable the appliance is, and then create a desire to purchase in his mind by showing where it will in some way be beneficial to the customer to install the apparatus. The result is a sale. AMERICAN ELECTRICAL HEATER CO.

T 2. Should heating appliances be sold at cost?

I think that heating appliances should under no circumstances be sold at more than cost, and I feel that the company would gain in the end by selling such apparatus at less than cost. From my standpoint I believe an electric light company is in business only to sell current. F. C. S., MALDEN ELECTRIC CO.

There is no particular reason why heating apparatus should be sold at cost. If it is sold at cost it means that you are going to conflict with other dealers who are handling and selling the goods, and thus arouse their enmity, or at least avoid getting their co-operation, which is always desirable and important. A device should be sold at a moderate cost—not at list price, but at a small, reasonable advance over the cost. This is desirable for several reasons.

First, the additional price secured helps the central station pay the cost of introducing the goods.

Second, it allows the outside dealer to sell at a slight advance, even though he is compelled to quote a somewhat lower price than he would ordinarily.

Third, because a slight difference in price has only an indirect bearing on the sale of the apparatus.

It is not likely that much more material will be sold if sold at cost than at a slightly higher price. After all, it takes advertising, solicitors, *et cætera*, to introduce the material.

AMERICAN ELECTRICAL HEATER CO.

The more appliances introduced, the more current will be sold; the lower the price of any article, the greater the quantity sold; and because to a very large extent it has been the practice of gas companies to sell heating goods at cost, there are many strong reasons for saying yes.

The addition of 10 or 20 per cent to the purchase price is frequently made, to cover transportation and other expenses incident to delivering the goods, and the resulting price is counted as cost. Where this practice is carried out, central stations will frequently get the co-operation of the dealers instead of their opposition by allowing this small margin over purchase price, and in determining the selling price it is worth considering.

JAMES I. AYER.

They should be sold at a price which should cover only the first cost and expense incurred in handling them.

C. D. W., N. Y. ED. CO.
E. R. FRENCH.
H. E. RYDER.

At cost, or not to exceed 10 per cent over cost.

PERCY INGALLS.

We think heating appliances should be sold at cost.

W. E. H.

T 3. What is your actual average revenue per month from an electric iron?

Domestic laundry irons $2.00 per month; tailor's irons and hat irons $5.00 per month. C. D. W., N. Y. ED. CO.

This naturally varies, depending on the kind of iron and the size, but mostly on the price charged for current. The price varies so in different localities that it is almost impossible to state definitely what the revenue is, as so many different things have to be considered and have a direct bearing on the result.

The average household and laundry iron brings in a revenue of approximately 15 to 25 cents per week, that is, at average lighting rates ranging from 8 to 15 cents per unit. Of course in some families the iron is used only a short length of time each week, as possibly most of the laundry is sent out. In other cases, all of it is done at home. The writer, however, has investigated, has personally made tests and taken records at home and from others, and the above estimate is approximately correct.

AMERICAN ELECTRICAL HEATER CO.

T 4. Should the automatic handle on electric laundry irons be required by the National Board of Fire Underwriters?

This restriction should be applied at the option of the local board, if there is one. If your public are not familiar with electric irons—yes. C. D. W., N. Y. Ed. Co.

The automatic handle on electric laundry irons should not be required, for a number of reasons. In the first place it is not necessary, nor even desirable, for the safe and satisfactory operation of electric irons. It does not prevent fires, because it has been shown that there are about as many where the automatic handle is used as in places where it is not. Ordinarily, the operator gets tired of continually holding down the lever and he takes a little twine or tape and ties it down. In addition to this, it is more or less of a nuisance. It increases the cost of the apparatus, and it increases the liability of trouble, as there are springs, contacts and parts which will wear out and which have to be renewed and replaced, and usually it is necessary to secure the services of an expert electrician to repair them.

If the ordinary electric iron is installed with a small incandescent lamp connected in multiple with it so as always to show whether the current is on or off, the danger of the iron being left with the current turned on is practically eliminated, and the best and most satisfactory results are obtained.

AMERICAN ELECTRICAL HEATER CO.

No. It is more bother than it is worth. It is likely to give out before the iron itself and is tied down in most cases when local insurance rules require its use. Fires started from electric irons are very few. E. R. FRENCH.

T 5. Does electric heating in the present state of development call for a special rate by the central station?

For cooking, yes; not for general room heating, for the electrical radiator from a heating standpoint alone is an inefficient device. Forced circulation of the hot air should be advocated.

C. D. W., N. Y. Ed. Co.

Yes. Electric heating is principally a day load, and companies can afford to give special rates and should do so.

E. R. French.

This question is rather broad. A special rate is not necessary where ordinary flat-irons and such small devices are operated in the household. We do not refer to cooking ranges, as at the present time the average central station can not make a rate low enough to induce electric cooking on any large scale.

In the industrial field electric heating is used in many operations and for many purposes, and it is undoubtedly necessary to quote a special rate if the apparatus is to be operated in competition with that heated by other fuels. It is impossible for a laundry to operate electric irons in competition with gas if regular lighting rates are charged. There isn't the slightest doubt but that the field warrants a special rate. No one who has given this matter any attention whatsoever can question this.

American Electrical Heater Co.

Undoubtedly special rates should be quoted for electric heating for all individual purposes, and it should be treated much the same as motor loads. For domestic service where any extended use is desired it should be encouraged with a special rate.

Special rates are necessary for general cooking, and where this work is undertaken they must be made. Special rates are not necessary and never will be for the service of such heating articles as are used about the house on lamp sockets, such as small water heaters, appliances for the nursery, sick-room and dining-room. The cost for operating this class of apparatus never creates an appreciable increase in a customer's lighting bill and is never expensive at the highest lighting rates.

James I. Ayer.

Electric heating in the present state of development requires a special rate in competition with other methods of heating, notwithstanding the recognized advantages favoring electrically heated areas. The Brooklyn Edison, E. W. Phillips.

Manufacturers using electric power are permitted by our company to connect heating devices to the power circuits. We

also offer power rates (five cents per kilowatt-hour) to any user of heating devices whose business will justify a separate meter for this purpose.
P. H. Korst.

If it does, use your power rate.
Percy Ingalls.

Electric heating in the present state of development does not call for a special rate by the central station.
B. J. Denman.

T 6. At what rate per kilowatt-hour will electricity compete favorably with dollar gas for cooking?

If the individual heating unit is used and the devices are in the hands of a good operator, four cents per kilowatt-hour.
C. D. W., N. Y. Ed. Co.

From a rather limited experience it appears that three cents per kilowatt-hour will compete very favorably with dollar gas.
H. D. Larrabee.

At the present time it is absolutely impossible to compete with dollar gas for cooking, unless a very low rate is quoted; furthermore, the time is not ripe for the general introduction of electric cooking ranges for kitchen cooking if they are to be sold and operated in competition with gas or coal stoves.

The rate would have to be less than three cents per kilowatt-hour.
American Electrical Heater Co.

Two and one-half cents.
James I. Ayer.

***T 7. At what price must electricity be sold for heating to be on a par with gas at $1.00 per 1000 cubic feet?**

Between 1.5 and 2 cents per kilowatt-hour.
C. D. W., N. Y. Ed. Co.

It is practically impossible for the average central station to quote a sufficiently low rate on electricity to enable it to compete with gas at $1.00 per thousand feet for ordinary heating purposes.

The rate would have to be less than one cent per unit. This ought to be answer enough.

Electric air-heaters to-day are not sold for general heating purposes, but for use as auxiliary heaters for small bath-rooms, corners of rooms, *et cætera,* where the actual cost of operation is hardly taken into consideration and where the cleanliness, convenience, freedom from odor, *et cætera,* are of more importance than the cost. AMERICAN ELECTRICAL HEATER CO.

T 8. At what rate per kilowatt-hour will electricity compete favorably with dollar gas for residence heating?

The heating of residences by means of electricity is out of the question. To compete with dollar gas, the rates would have to be less than one cent per kilowatt-hour. No electric heating manufacturer or engineer of any reputation or responsibility even remotely suggests the sale or introduction of electric heaters for residence heating.

AMERICAN ELECTRICAL HEATER CO.

About one cent. JAMES I. AYER.

T 9. How large a single-phase motor do you permit on your general lighting supply mains? What size single-phase motor have you found would actually interfere with proper regulation of your general lighting supply mains?

I do not think that the largest-size single-phase motors will interfere any more with voltage than polyphase motors, provided that in both cases you have ample transformer and generator capacity and that your engine governors operate as they should. I think much of the voltage drop blamed on single-phase motors is due either to lack of transformer or generator capacity or the engine governor not working freely.

F. M. VANDER VOORT.

Our largest single-phase motor is one of 15-hp, operating an ice machine. It seriously affects the incandescent lights on that circuit. We are of the opinion that it is the character of the load rather than the motor which causes the fluctuation.

W. H. Fellows.

We have single-phase motors of three different makes up to 15-hp on our lighting circuits and have found it necessary to forbid their use during the lighting hours. All single-phase motors we have in use interfere with the proper regulation of the lighting supply mains when they start.

United Elec. Lt. Co.

We have one 15-hp Wagner on a 220-kw direct-connected rig. Would not put on over a 5-hp now. R. N. Kimball.

Five-horse-power. We find that at times this motor interferes somewhat with regulation, but not very badly.

H. D. Larrabee.

We have 5-hp single-phase motors on lighting feeders. In special cases 10-hp might be permitted. Have not yet had motor on system large enough to interfere with lighting service.

The Colorado Springs Elec. Co.

Three-horse-power generally. In some specific cases 5-hp. These cases are where motors are not used after four o'clock p. m.

F. C. S., Malden Electric Co.

We permit single-phase motors under 3-hp, without special starting devices; 3-hp and over must be 220-volt with starting device. We have found that 10-hp single-phase motor does not interfere with the proper regulation of the lighting supply mains. W. E. H.

One-horse-power; this is as large as we believe it is policy to use. G. H. Cushman.

Hold single-phase motors below 5-hp if practicable, and if you have many motors of 2-hp and over, would advise the use of a polyphase circuit.

The amount of interference depends to a great extent upon ratio of line and transformers to load, and is likely to increase in a growing plant. RALPH R. LAXTON.

Four to six horse-power. C. C. GARTLAND.

T 10. What is the best method for starting induction motors without the aid of a starting compensator, motors ranging in capacity from 50 to 150 horse-power?

Presuming the question has reference to squirrel-cage and not high-resistance type motor, would suggest using transformer with a tap brought out at the middle point or between the two coils. This, by means of a double-throw switch, would permit the motor's being started on half voltage, and when it has attained speed it could be thrown to the running point, thus throwing the full line potential on the motor. M. C. TURPIN.

The most satisfactory method for starting such motors is by the use of a variable resistance in the secondary element, unless it is possible to bring the motor to speed by some extraneous power. This latter method is employed in some cases where motors are used to help out steam or water power.

WM. B. JACKSON.

Use motors with resistance in secondary. It is hardly practicable to start large motors of the squirrel-cage type from rest without compensator, even with no load, unless you have excessive generator capacity and do not mind severe disturbance of regulation. RALPH R. LAXTON.

Introduce resistance in rotor. C. K. N., N. Y. ED. CO.
W. H. WOLVEKAMP.

T 11. Owing to compensator types of polyphase motors taking as high as seven times full-load current at starting, should not

the inside wiring be large enough that no excessive drop in volts occurs, or the Underwriters' safe-carrying capacity is not exceeded at starting?

This would mean considerably increased expense for apparently no very good reason. The rush of current lasts only a short time and the only appreciable effect is the possible dimming of lights while the motor is starting. M. C. Turpin.

No; because the starting current lasts only a short time and any excessive drop can be easily taken up by moving the taps on the compensator. The compensator is installed for the express purpose of reducing the voltage on the motor at starting so that the extra drop in the wiring would not be serious.

H. D. Larrabee.

As the starting period is of short duration, the limit might safely be somewhat below that allowed for continuous service. As the function of the compensator is to reduce terminal voltage, the excessive line drop would not be a serious item.

Ralph R. Laxton.

By all means. Furthermore, automatic circuit-breakers should be introduced in all motor circuits for starting and stopping polyphase induction motors of all types and sizes above 30 horse-power. Fuses carrying terrific currents and wires acting as fuses would then be done away with. We have had two meters entirely destroyed by fuses failing to blow on two 50-hp motor installations and the insulation entirely burned off the wires leading into the meters; size of wire in both cases No. 4 B. & S. gauge, distance to motors less than 25 feet.

F. D. Sampson.

Yes. C. K. N., N. Y. Ed. Co.

T 12. Is it good policy to install single-phase alternating-current motors when frequency is 133 cycles?

No. This frequency is obsolete and will undoubtedly soon be superseded altogether by a lower frequency. The motor would have to be specially built, unless it was a motor designed for 125 cycles, in which case it would, of course, run at an increased speed and a lower torque and efficiency. Manufacturers are trying to discourage the use of these higher-frequency motors.

VOLAMPWAT.

If the power work is a considerable item, it would pay to change over to a system of lower frequency. Very small 133-cycle motors might be found satisfactory, but the 133-cycle single-phase system is not a very "big stick" from any point of view.

RALPH R. LAXTON.

No; unless you limit the size to fan motors.

F. D. SAMPSON.

Yes, if the amount of business is small and does not require over 5-hp motors. H. E. RYDER.

Yes, under some conditions. Motors must be small.

C. K. N., N. Y. ED. CO.

A great many central stations are operating 133-cycle motors and the results are perfectly satisfactory; in fact, they are just as satisfactory as 60-cycle motors, but the fact that they cost much more to build than 60-cycle motors and do not have as high an efficiency is the principal reason why they do not meet with very much favor, for when central stations begin to work up a motor trade they generally change their station to 60 cycles so that their customers can purchase motors on which the price is not almost prohibitive. CENTURY ELEC. CO.

T 13. Which is the better for general power work, a motor with a high or low efficiency?

If motors are wound for special machines they should be wound for maximum efficiency at a per cent of full load equal to load factor of machine. C. K. N., N. Y. ED. CO.

High efficiency is better for both producer and consumer. Every increase in efficiency tends to keep customers better satisfied, and to postpone the day when you will have to increase station capacity in order to take new business.

RALPH R. LAXTON.

High efficiency. E. A. M., N. Y. ED. Co.

A motor of low efficiency would be a bad proposition, both for the system and for the work. F. D. SAMPSON.

T 14. What would be the general effect on a three-phase system if induction motors were run constantly 15 per cent below their rated pressure?

Bad from every standpoint. The torque of an induction motor varies as the square of the voltage, and if your motors are loaded anywhere near the point of maximum power factor and efficiency the reduction in voltage will be disastrous. If the voltage is to be reduced at station it will amount to limiting your generator capacity; and, assuming the same service to be performed as before, the line loss will also be increased as the square of the amount of reduction in impressed voltage. Keep your voltage up. RALPH R. LAXTON.

The output of an induction motor varies with the square of the voltage applied. This would mean that the motors would be developing only about 73 per cent of their ratings.

M. C. TURPIN.
E. A. M., N. Y. ED. Co.

The effect of running induction motors 15 per cent below their rated pressure would be that the motors would only pull 75 per cent of their normal rating.

THE PHILADELPHIA ELECTRIC CO.

It would cause the motors to drag when well loaded and thus reduce the power factor at the time of heaviest loads.

H. D. LARRABEE.

You would undoubtedly have a lower power factor on your system, for your motors would not be up to synchronous speed.

F. D. SAMPSON.

T 15. Why are two-phase motors cheaper than single-phase? Which motor wears the better, single or two-phase on same kind of work? Is there any difference in consumption of a 3-hp single-phase as compared with that of a 3-hp two-phase motor?

A single-phase motor will not start by itself, consequently some phase-splitting device must be furnished with the motor. Owing to this fact, the prices of single-phase motors are greatly in excess of that of polyphase motors of the same output. If the question refers to mechanical wear, can see no reason why there should be any difference between the two. The current consumption is probably less on the two-phase motor, owing to the higher efficiency obtainable.

M. C. TURPIN.

Multiphase motors are cheaper to build than single-phase.

First, because a given amount of metal will produce a greater output when wound multiple than when wound single-phase.

Second, the multiphase motors as made to-day are rated much closer than single-phase.

Third, a single-phase motor has to be capable of developing a great deal more than its rated capacity so as to develop full-load torque, which makes it capable of really developing (when properly wound) a much greater capacity than that for which it is rated, while the multiphase motor develops its greatest torque when the speed is nearly synchronous.

There should not be any particular difference in the efficiency of the two-phase or single-phase motor. There may be a very small percentage, but not enough to be a governing item, in a decision as to whether the single or multiphase motors should be purchased. It is hard to say which wears the better—single-phase or two-phase motors. We can point to hundreds of single-phase motors that have been operating apparatus seven or eight years, some of them twenty hours per day, and there has not been a cent spent on them, outside of possibly one or two sets of carbon brushes costing at the outside, 60 cents per set.

CENTURY ELEC. CO.

T 16. What has been the experience of electric light companies in introducing the use of motors for refrigerating plants?

One installation one year old, 18-hp, replacing engine-driven apparatus in beef house; thoroughly satisfied customer. Another 7.5-hp, retail provisioner, new establishment; thoroughly satisfactory.
D. L. OTT.

T 17. At what price per kilowatt-hour will electricity for motor power compete favorably with natural gas at 27 cents per 1000 cubic feet? Gas has a value of 1000 B. t. u.

Half a cent per kilowatt-hour.
C. K. N., N. Y. ED. CO.

T 18. What has been the experience of companies with regard to electric heating?

Among our residential customers the cost of special wiring and the cost of the device itself prove greater objections to the use of the articles than the cost of operation. We find that the use of the electric radiator is limited at present rates; and the pushing of general heating should be done with a great deal of care. We find that the flat-iron is the most salable article. This is the only device worth handling by the central station.
C. D. W., N. Y. ED. CO.

T 19. What special discount is given, if any, to customers using small heating appliances or motors not large enough to justify a separate meter?

Such small users should be on regular lighting rates.
C. K. MUNNS.

Not in the sense intended in the question. However, the addition of heating apparatus to an installation will often increase the consumption to such an extent as to admit of the application of a wholesale rate, thereby reducing the average rate.
C. D. W., N. Y. ED. CO.

T 20. Can the heat given off by transformers and regulators in a substation be used to any advantage?

In street railway work, the heat given off by transformers and regulators may be returned to the car to help out the interior heating. C. D. W., N. Y. Ed. Co.

T 21. What has been the experience with companies with welding transformers on their lines in regard to voltage regulation? Transformers 15-kilowatt or larger.

A test made on a welding machine on our circuit at Newark shows as below:

	Ammeter	Voltmeter	Watts	Watts by Indicating Wattmeter	P. F.	H. P.	Per Cent Volts Drop
First period ...	32	237	7584	6200	81.7	8.3	4.4
Second period .	37.5	235	8813	7100	81.7	9.5	5.2
Third period...	42	231	9702	7950	81.9	10.7	6.9

The first point or starting current lasted 19 seconds.

The second point lasted 10 seconds and then for 20 seconds it varied between first and second points.

The third and final point lasted one second. Total operation consumed 50 seconds.

The material welded was steel one square inch, a quarter of an inch thick, voltage 248, transformers General Electric 10-kw, oil type; secondary, 100-foot run of No. 4 wire.

J. J. Gaffney.

The Cleveland Electric Illuminating Company has two welding installations on its lines. The smaller of the two consists of one 50-ampere and two 25-ampere, 300-volt welders, which are connected to the three phases of a power circuit, one machine across each phase.

The largest of these machines requires but 7.5 amperes primary current, and as the average feeder load is about 100 amperes per wire, regulation would scarcely be affected by the sudden coming on of one 15-kw welder. No attempt, however, is made by this company to regulate pressure on power circuits.

The second installation consists of a larger number of welding machines of 100-ampere capacity and over, having a total single-phase capacity of about 170 kilowatts. This is distributed over the three phases. This installation will also have a number of three-phase motors, and is on a circuit by itself. The load is likely to be badly out of balance, sometimes becoming a 100-kw single-phase load. The power factor varies between 60 and 70 per cent.

No attempt is made to regulate pressure, which is likely to vary 12 to 15 per cent at customer's premises.

Robert Lindsay.

We are operating about 30 kilowatts in transformer capacity connected for 330 volts for operating one welding machine taking from 40 to 100 amperes. We have only recently been operating this machine, but find that it is a very intermittent load, current being on only about three-fifths of a second at one time. On a class of work having twelve points of contact to weld, we found that the machine took 70 amperes and was in actual operation 14.4 minutes in a day of ten hours, the rest of the time being used up in handling the work.

This machine causes a 6-volt fluctuation, on a recording voltmeter. L. C. Whitney.

We have a 30-kw Thomson electric welding outfit on our line and, from the experience here, the proposition is not serious so far as regulation is concerned. It is certainly no more serious than the presence of large motors with changing load upon lighting lines, as the period of maximum current is very short, and i the load be balanced across the phases it shows as an instantaneou dip, if at all. On days when an average of 240 welds per day hav been made we did not know that the machine was being used a all. The Philadelphia Electric Co.

There are a few of about 1.5-kilowatt capacity in service o our lines here, and these do not affect our voltage regulation.

Walter I. Barnes.

We have built all the electric welding machines in operatio in this country, most of which are operating from generators our own manufacture; there are, however, some welding machines located in the principal cities, operating on city lighting and power companies' lines with satisfaction both to the operators and the parties furnishing current. We would name especially the cities of Cleveland and Philadelphia.

Welding machines can be operated on a single-phase alternating current of from 50 to 60 cycles at any voltage between 200 and 350, preferably 350.

In furnishing current for electric welding purposes, it must be noted that the full amount of current required for the work is instantly thrown on the source of power when the switch is closed in the welding machine; there is no building up, and when the weld is completed and the switch in the welding machine opened, all power is instantly released.

As soon as the next weld is made, which may be in small wire at intervals of a few seconds, or in stock one inch in diameter at intervals of thirty seconds, the process is repeated, continuing in this intermittent way while the welding machine is being operated. No current is used in the welding machine except when the stock is heating. The use of our welding machines on city lighting and power circuits is constantly increasing and we believe will grow to considerable proportions and should be a source of some revenue to the power and lighting companies. W. H. Hodges.

We have two companies that operate welders at their factories, the supply of current coming from the same transformers as the power and lighting service for their shops, the system being 2-phase, 60-cycle, 220-volt on the outside wires. The welders are connected across the outside wires of the two phases, at which point 308 volts is derived, which is the required voltage for the satisfactory operation of the welders. These welders operate very satisfactorily and cause no serious fluctuation of the voltage. R. W. Rollins.

We would advise installing a separate transformer for welding machines. The no-load voltage of a 15-kw transformer was 110 volts, but when a welding machine used to weld copper wire was connected to one side of a 3-wire system the voltage dropped to 104 and 102 volts, the machine taking 90 to 120 amperes during the test. When both coils of the transformer were connected in multiple to the machine the drop was to 105 and 108 volts. We use a separate transformer of 5-kw capacity for each machine, as the time is only about 15 seconds for welding a wire. With this sized transformer we have had no trouble.

CAMBRIDGE ELEC. LT. CO.

We have installed in the Newton Steel Wheel Company's plant one Thomson electric welder Type 10-A, 75-ampere, 220-volt. This machine is used in welding steel wheels. Their maximum demand is about one-half of machine's capacity. We give service to this machine through a 10-kw transformer, which also serves for lighting the shop. We make a minimum charge of $5.00 per month. This welder works finely, but is likely to interfere with lighting service from same transformer unless same has plenty of capacity. W. P. STEPHENS.

We have several of these electric welding machines on our lines here. Our experience has been that where the plant and lines of a company are of sufficient capacity so that the transformer forms only a small portion of the load, no serious trouble is experienced in voltage regulation. On lines of insufficient capacity a marked fluctuation in voltage is noticed when these machines are in use. C. C. COLLINS.

U—METERS

U 1. What is a good formula by which to assign the sizes of meters for different numbers of lights (and various amounts of power) in different classes of buildings?

I do not think there is any general formula that can be used for this purpose. We do not use any meters smaller than 10 amperes on single-phase, 110-volt lighting. Practically 90 per cent of all meters for residential use are 10-ampere. The writer thinks that this sized meter will cover even a larger percentage of the installations for residential work than this, as the modern induction meter is capable of large overloads for two or three hours. For public buildings, stores and factories we usually install a meter of capacity 75 per cent to 80 per cent of the maximum demand. F. C. S., MALDEN ELECTRIC CO.

Private residences take 40 per cent of lamps installed. For stores figure all the lights and rate meter as being able to carry 50 per cent overload. A. PETERS.

Speaking generally, offices 50 per cent, residences 30 per cent, stores and factories 75 to 100 per cent, according to conditions.
J. W. C., E. E. I. Co., BOSTON.

No uniform formula can be adopted to cover this question, owing to the widely-varying conditions. In residence lighting it is customary to assign about 50 per cent meter capacity to the actual connected load. In business houses, *et cætera,* meters of sufficient capacity to meter the entire connected load should be installed. In installations, such as halls, churches, theatres, *et cætera,* where the load is fairly constant, and in installations such as arc lamps or electric signs, a meter of the capacity of the load or even a little larger should be installed in order to obtain the highest efficiency. On power installation it is considered good practice to install meters of about 1000-watt capacity per horsepower. THE PHILADELPHIA ELECTRIC CO.

In general, let meter be rated at 60 per cent of connected load. However, each installation should be considered individually. H. A. STRAUSS.

Use as small a meter as possible to insure best ordinary and light-load accuracy. We find that meter of the capacity of the normal burning load is usually best adapted, assuming that the overload capacity of the meter will be sufficient for abnormal loads. TOLEDO RAILWAYS AND LIGHT CO.

U 2. Which would be the best system of installing meter —selling to consumer or renting, or requiring a deposit to cover cost of meter?

I think the best plan is to furnish the meters at no expense to the customer, but make a minimum charge based on the size of the installation. Where there is a doubt of the customer remaining in business or of his paying promptly, require a deposit of approximately his average bill, as a guarantee of good faith. Customers that pay for their meters can make trouble, and I find that any charge outside of that for current, whether it be rent for meters, or however it is designated, is looked upon by many customers as an extra fee and a pretext to complain. The minimum charge should be arranged to cover all these items and would principally come out of the short-hour customer while the long-hour customer would be encouraged in every possible way.

S. S. INGMAN.

The best system of installing meters is to make no charge for the installation. Where you are charging for your services on the basis of current delivered, with a fixed minimum charge, it is not fair to make the consumer bear the burden of the cost of the meter, either through a sale or a rental charge. P. S. YOUNG.

At present we require deposit of $10 on all meters, regardless of size. It is our intention to limit this requirement to tenants in the future and have all others sign a contract guaranteeing us reimbursement in case meter is destroyed by fire or otherwise.

Customers of questionable credit, $20 deposit.

Local conditions may make it advisable to allow interest (say, two or three per cent) on deposits.

Accounts are not allowed to exceed deposit.

FRANK BECKWITH.

We charge a rental on all meters, and in cases of consumers of questionable financial standing we exact a deposit to cover part value of meter. J. J. CAGNEY.

Renting, if you are compelled to adopt one of the three policies. Customers do not like deposits. Selling might interfere with proper inspection and repairs.

Personally, I prefer a rate covering meter as well as service, since I have never been able to see why a separate item of account should be made to cover one piece of apparatus more than another. By the average customer this item is looked upon as so much "graft." RALPH R. LAXTON.

We believe the central station should own the meters in use on its line rather than sell or rent them to customers. We do not require a deposit to cover cost of meter in any event, but in cases where credit is poor we require deposit covering estimated amount of monthly bills. We furnish all meters and render bills in no amount less than $1.00 per month.

T. H. T. & L. Co.

I do not think that there should be any charge for installing a meter, such as selling, renting, or requiring a deposit to cover same. I think if any fixed charge is to be made to a customer, it should be a minimum charge of $1.00 a month or so-called "readiness-to-serve" charge. F. C. S., MALDEN ELECTRIC CO.

(Practically concurrent opinions expressed by F. ELLWOOD SMITH, W. E. H.)

Best system is to make no charge for meter; let your rate cover your fixed charges in the investment in addition to the operating costs. H. A. STRAUSS.

H. M. BEUGLER.

Neither. Always install and own meter.

J. W. C., E. E. I. Co., BOSTON.

Our gas friends have always furnished meters free of charge, placing a fair minimum monthly charge on same, and all things considered, I believe this the best course to pursue; at least, I have found it so. J. H. ENRIGHT.

If a customer is worth having, he is entitled to a meter at the company's expense. PERCY INGALLS.

U 3. What is the best explanation or reason to give customers for requiring a meter deposit?

Where a consumer is a property owner or his application signed by a responsible party when application for service is made, which will insure payment of bills, no deposit should be made or asked for.

Tell the applicant his credit is such that you are justified in demanding a deposit which will cover a month's consumption.

H. M. Beugler.

The best explanation is that which appeals to the customers' sense of fairness, namely: That the company or person selling the current can not collect for same until sometime subsequent to delivery, therefore the deposit is required as security for the payment for current used. Of course, where a customer has an established credit it is good business policy to waive the requirement of a deposit. P. S. Young.

We justify a $10 deposit as follows: Each meter costs the company from $11 up. The company can not ensure scattered meters against loss by fire. The deposit may be considered as a guarantee for payment of bills. This may not fit "your" case, but to avoid unpleasantness we can not make an exception. (We intend to make the exception stated in answer to U 2, but as rules will be published, the uniformity of treatment of customers will hold good.) Frank Beckwith.

The presumption in asking for a deposit is either that you have no acquaintance with or knowledge of the applicant, or else that you are not satisfied with his financial standing. It would seem better, therefore, to state frankly that the policy of the company is to be assured that its bills will be paid, but that the fact of asking for a deposit does not necessarily imply that the party making the application is not of sufficient responsibility to justify the acceptance of the application without a deposit. Our practice is to ask for a deposit unless we can be otherwise assured that the party is able to perform his contract obligations.

C. A. L., N. Y. Ed. Co.

No deposit should be required for the meter. Tell the customer you do not know him, and ask a deposit sufficient to cover his probable account. Percy Ingalls.

U 4. Should more than one meter deposit be required from a customer having a meter at his place of business and one at his residence?

If it is necessary for customer to make a deposit on account of poor credit, and he has service in both residence and place of business, he should either make two deposits, or make one in sufficient amount to cover both places. T. H. T. & L. Co.

. Generally speaking, the meter-deposit scheme produces more enemies than friends, and should be used only in cases where unreliability of party in question is well known.

J. H. ENRIGHT.

We think that freeholders of credit should not be required to deposit; but tenants should be so required on each and every installation of meter. See U 2. FRANK BECKWITH.

If a company is going to require a meter deposit, I see of no reason why it should not require a deposit for each meter, irrespective of where it is placed.

F. C. S., MALDEN ELECTRIC CO.

Where a party is a customer at one address and has paid a deposit, it would hardly seem justifiable to ask a second deposit for other classes of service at the same address unless satisfied that he is not able to perform his contract obligations, in which case the deposit might be increased instead of asking for a second deposit. C. A. L., N. Y. ED. CO.

If you can not trust him in one place and your deposit is not large enough to protect both accounts, ask for more.

PERCY INGALLS.

U 5. What limit do you impose on the number of meters installed on the premises of any one customer; and what charge, if any, or what difference do you make in the rate or minimum charge, if more than one meter is installed?

We install as many meters as may be necessary to meter the customer's installation properly. This does not imply that a meter will be furnished merely upon request that it be installed, but when our inspector has satisfied himself that two or more meters are necessary to meter the installation properly, the additional meters are installed without expense; but in every case we insist that the wiring be made complete by the customer. Oftentimes a party wishes several meters installed, in order that he may note the consumption in various departments of his factory, and when convinced that additional meters are justified, we allow them to be installed. If we are not satisfied we ask the applicant to pay a cost of $5.00 for each meter installed.

C. A. L., N. Y. Ed. Co.

It is the practice of this company to install in premises of the customer separate meters for light and power, the contract for each providing for a monthly minimum guarantee of $2.00. In cases where the owner of the building furnishes light to tenants, the company may provide memorandum meters without charge or an additional minimum guarantee.

The Brooklyn Edison, E. W. Phillips.

No limit. In cases of minimums, the conditions vary. In some cases no minimums are charged on submeters, such as are installed for apartment houses, and so forth. In other cases where power and light meters are installed for one consumer a joint minimum is charged covering both meters.

The Philadelphia Electric Co.

Generally speaking, only one meter allowed per contract. Additional meters only allowed under special conditions.

J. W. C., E. E. I. Co., Boston.

We do not impose any limit. Have never had abnormal conditions where such would be necessary. We make no difference as to minimum charge to a customer that has more than one meter, as I think we do not have any case where a customer having more than one meter does not exceed many times our minimum charge of $1.00 a month. F. C. S., Malden Electric Co.

A meter is installed for each class of service. There is no difference in the rate or minimum charge if more than one meter is installed. B. J. DENMAN.

Make a minimum charge for each meter, the same as for each individual installation. S. S. INGMAN.
F. ELLWOOD SMITH.

If one meter is all the company requires on the customer's premises, but the customer wishes other meters for his own convenience, we charge him rental of $3.00 per year on all meters in excess of the first one. W. E. H.

No limit is placed on number of meters. A 25-cent meter rent is charged for every meter set, with a minimum rate of 75 cents for current, making minimum bill $1.00.
W. H. FELLOWS.

We have a sliding scale for current used on any one meter. It is to the consumers' interests to use as few meters as possible.
R. N. KIMBALL.

We have only one customer with more than one meter installed (two). A deposit for only one meter, or $10, is required for both. As he is freeholder of credit, deposit will be refunded. See U 2. FRANK BECKWITH.

U 6. (a) In case a city intends to provide for testing and inspection of electric meters under municipal supervision, should the electric light company encourage or oppose such a move? (b) Is there municipal supervision of electric meters in any city at the present time? (c) Give text of ordinance creating such supervision.

(a) If your meters are accurate, the municipal test will merely confirm this and the practice should enure to your advantage.

(b) Yes, we have such an ordinance.

(c) See 57-58 Victoria, Chap. 39, Statutes of Canada, entitled "An Act Respecting the Inspection of Electric Light."
J. J. CAGNEY.

(c) See laws of Wisconsin. Chapter 459, Section 6.
R. N. KIMBALL.

Encourage the city to do so. Should a meter be incorrect let us know it by all means, as well as have our consumer know that we stand for a "square deal." J. H. ENRIGHT.

Should be encouraged if the measure is honestly drawn. Such a measure should save some expense in looking after kicks and be a means of producing better feeling between the company and its customers. The trouble with municipal supervision of any public service is that it is likely to be a political club and degenerate into a scheme of graft, even if it is honestly conceived. S. S. INGMAN.

(a) Yes, provided reasonable conditions can be fixed covering this work. The difficulty would probably arise in this latter feature. We believe an efficient test of meters after the manner mentioned would prevent a large amount of complaint and kicking about the meters that is now experienced. To be able to refer to an officially-tested meter appears to us an unanswerable argument in such cases. L. W. EMERICK.

(a) The company that has a thoroughly efficient meter system has nothing to fear from reasonable municipal supervision. In fact, a fair and reasonable provision for testing and inspection of electric meters under municipal supervision should be of advantage to the company in securing public confidence, and should in my judgment be encouraged rather than opposed.

Frequently co-operation in the framing of such a provision will secure one that is fair and eminently satisfactory, whereas opposition may lead to the adoption of a provision that is unjust and injurious to the company's interests.

(b) Under the charter of the city of New York, the commissioner of water supply, gas and electricity is given the authority to test and inspect electric and other meters upon complaints of customers and under certain regulations. This provision of the charter has been practically inoperative in Brooklyn, as not more than two or three complaints are made annually, and in each case to date, the meter has proven satisfactory on test. The provision that the customer must pay the cost of the test if the meter is proven to be accurate is probably an effective deterrent to customers who would be inclined to avail themselves continually of a test if it would involve no possible expense to them. Legislation is now pending in the state legislature transferring such meter testing to the State Commission on Gas and Electricity with practically the same powers and restrictions.

(c) The present city ordinance above referred to is contained in Section 519 in the charter of New York, which reads as follows:

"The said commissioner of water supply, gas and electricity shall cause inspection to be made of electric lights furnished to the city, and of electric meters and electric wiring, as such tests may be provided for by the proper appropriation; the said commissioner shall cause tests to be made of all meters in use in said city for measuring or ascertaining the quantity of electricity or steam furnished by any corporation or person in said city within one year after this act shall take effect; and thereafter no corporation or person shall furnish or put in use any electric or steam meter which shall not have been inspected, approved and sealed by the inspectors, and every such corporation or person shall provide and keep in or upon their premises a suitable and proper apparatus to be approved and sealed by the inspector for testing and proving accuracy of meters furnished for use by them. Whenever a meter shall be inspected the inspector shall attach thereto seal, stamp, or mark, with the inspector's name, the date of his inspection and whether or not the meter is accurate. Meters in use shall be reinspected and tested on the written request of the consumer, or of the company, in the presence of the consumer, if desired. If any such meter on being tested shall be found defective or inaccurate to the prejudice or injury of the consumer, the necessary removal, inspection, correction and replacing of such meter shall be without expense to the consumer; but in all other cases, except where the change is beneficial to the company, he shall pay the reasonable expense of such inspection and the reinspection shall be stamped on the meter. Provided, however, that nothing herein contained shall be construed as requiring to be sealed, electrolytic or other electric meters, which in their construction or use are not susceptible of being sealed, nor the apparatus employed in taking the usual periodic readings therefrom; but all such meters shall, in all other respects, be tested and stamped in the manner provided herein for other meters; and every corporation using such electrolytic or other meter shall at all times admit the inspector to the meter department and reading-rooms, and permit the inspection by him of all meters and of all the processes and methods and operations of measuring electric current consumed by it." THE BROOKLYN EDISON, W. W. FREEMAN.

A state or municipal source of appeal in case of dissatisfaction of the customer may be encouraged, but any general supervision over meters, putting them under state or municipal seal, is to be opposed. J. W. C., E. E. I. Co., BOSTON.

(a) It will be much easier for an electric light company to have its meters tested in cases of complaint of bills by the municipal authorities, for the burden of proof will then be on the customer rather than on the company.

(b) The municipal authorities test meters on application.
C. A. L., N. Y. ED. Co.

If they do it in a fair way to both consumer and company, we should consider it a good thing. If the meter is found to be fast, the company ought to pay the overcharge; if the meter is found to be slow, the customer ought to pay the undercharge. This would probably stop a good deal of comment about fast meters.
LUDWIG KEMPER.

Electric light companies should favor municipal supervision of meter testing, but at the same time should have competent men to conduct tests and guard against possible errors a municipal inspector, or, in fact, any disinterested party, might make.
W. H. GREENSLIT.

(a) The electric light company should advocate such a bureau for test and inspection. The reputation of the meter, its maker and manufacturer, would be instantly vindicated before the eyes of the public. The public should know that of all measuring devices the electric meter is the most nearly perfect, and this manner of publishing the fact should be encouraged.

F. D. SAMPSON.

(Practically concurrent opinions expressed by H. A. STRAUSS, PERCY INGALLS, RALPH R. LAXTON, TOLEDO RAILWAYS AND LT. CO., F. C. S., MALDEN ELECTRIC CO.)

U 7. Do meters which test O. K. in meter-room become inaccurate through handling while being placed in circuit?

Meters that test O. K. in meter-room may or may not become inaccurate from handling, but it is considered good practice to make a test as soon as possible after the installation of the meter.

THE PHILADELPHIA ELECTRIC CO.

(Practically concurrent opinions expressed by F. ELLWOOD SMITH, W. R. B., N. Y. ED. CO., J. W. C., E. E. I. CO. OF BOSTON, S. S. INGMAN.)

This sometimes occurs, especially where moving parts of the meter are exposed to dirt and dust while installing. Light load of the direct-current meter is sometimes affected when connections are not made in the same manner at the place of installation as they were at the meter-room, when under test.

See also the minutes of the Association of Edison Illuminating Companies, for 1905 convention, page 312.

TOLEDO RAILWAYS AND LT. CO.

Unless installed by competent men, and handled intelligently, bending of brushes, breaking of commutator lead, cracking of jewel, or shifting position of drag magnets, may frequently occur.

G. R. RADLEY.

We have frequently found such to be the case when the instruments were subjected to jolting or rough handling in trans-

portation. In transporting meters to and from consumer's premises, use wagon equipped with special cellular sections or boxes.
J. J. CAGNEY.

We believe they do, to a certain extent. W. H. FELLOWS.
E. R. FRENCH.

Yes; at least one in every ten does. WARREN PARTRIDGE.

Meters tested in meter-room and adjusted O. K. will remain O. K. after being placed in circuit if properly handled and installed. A little carelessness on the part of the man who tests the meter in not making sure all screws are tight and electrical joints have good contacts may result in meter becoming inaccurate soon after being placed in circuit. All tests should be rigid and meters very carefully handled. F. A. JOHNSON.

If meters are packed in excelsior when they are taken out on a wagon, or carried in the arm when on foot or wheel, there is no reason why they should become inaccurate.
THE COLORADO SPRINGS ELECTRIC CO.

No. If meters are carefully handled and reasonable care is taken in installation. E. A. VAUGHAN.

(Concurrent opinions expressed by J. J. GAFFNEY, F. C. S., MALDEN ELECTRIC CO., C. E. INMAN, A. H. GREENSLIT, E. C. DEAL, J. H. ENRIGHT, DAVID W. BEAMAN, H. A. STRAUSS.)

Small plants can not afford to pay for the services of an expert meter man, consequently linemen install meters and frequently "try it again to see if it is right" in the premises. Often at the end of the month the meter is found not to have moved, or the disc is too high or too low, and meter running slow. Our main trouble is that frequently linemen connect so that meter runs backward. FRANK BECKWITH.

U 8. Is it usual practice to test meters in circuit a few weeks after they are put up?

If the meters are of the commutator type it is a good idea to inspect and test a few weeks after installation, and if meter is found slow on light loads, and if the jewel is O. K., adjust speed by means of the adjustment-field, but do not clean commutator. The modern induction meter needs no special attention for several months. W. H. Greenslit.

Yes; test as soon as possible, to be sure installation is correct and meter moving, and test again in three months, when meter is cleaned as per instructions of factory and is then supposed to be in normal condition for future use; test then at intervals of three months. Frank Beckwith.

It is very good practice where companies can afford to hire men to do this work, but when the men are making periodic and complaint tests, reading and repairing meters, I think six months after installation is soon enough.

The Colorado Springs Elec. Co.

It is considered good practice to test meters in circuit within a few weeks after installation, and we endeavor to test such meters within one week. The Philadelphia Electric Co.

It is advisable to inspect the meter as soon as it is connected, and then make a regular test upon the customer's premises about three or four weeks afterward.

W. R. B., N. Y. Ed. Co.

Our practice is to satisfy ourselves that meter starts properly when first installed. The idea of testing meters some weeks after installation is, however, a commendable one.

J. J. Cagney.

Meters should be tested on customer's premises within a month of installation. E. R. French.

Warren Partridge.

J. W. C., E. E. I. Co. of Boston.

When meters are installed by apprentices it is necessary to have same inspected and given an "estimate test" by a competent man before the first bill is rendered. Should an error remain undiscovered for several months no settlement can be made except at a loss to the company and the greater loss of the customer's confidence in meters in general. G. R. RADLEY.

We do not do it. Our meter testers also set the meters. As these men know by experience that great care is necessary in handling meters in order that they retain their accuracy, we do not consider it necessary to make a test of the meter earlier than six months after it is set. DAVID W. BEAMAN.

No, not a usual practice.

J. J. GAFFNEY.
H. A. STRAUSS.
A. O. FRETZ.
W. H. FELLOWS.

U 9. What is the most satisfactory method of testing meters on customers' premises, and how many meters per day can one man test by the method given?

Portable testing outfit, combined voltmeter, ammeter and sometimes, also, standard wattmeter, using customer's meter and his own lamps for the test; meter man should use customer's lamps and explain speed, *et cætera,* and show test thoroughly after having first seen to the meter himself; explain and show difference between one, two and more lamps on meter, and leave with customer instructions how to roughly test his own meter. This eliminates very many unnecessary kicks. Always be cheerful, and don't fail to send meter tester up, however often, and before bill is paid, and have him prove that meter is right.

FRANK BECKWITH.

We find that a portable test meter with the register on top of three pointers, which reads directly in disc revolutions and is divided to read in hundredths of a revolution, gives the best satisfaction. Test meter is connected in series with meter to be tested and after counting revolutions on the latter, dividing by revolutions which will be shown on the pointers of the test meter will give percentage of error. This method eliminates all errors of the stop watch and slide rule, and one man can easily test from 18 to 20 meters a day. THE COLORADO SPRINGS ELECTRIC CO.

It is more economical to furnish the tester with a helper and then combine with the meter test a complete inspection of the wiring for leaks, taps ahead of meter, or concealed connections. Present methods of meter construction and installation make the theft of current very easy, while the morals of a large class of electric light users are such that they will take advantage of any scheme of which they hear, unless inspections are frequent. With two men in a party one can be tracing the wires, while the other connects in the portable instruments and fills out the report card.

The number of meters thus tested per day varies from five to ten, depending upon size of installation and distance between customers.

G. R. RADLEY.

By using a lamp bank or battery for load, determined by the capacity of the meter, then bridging the meter, thereby allowing the consumer to have uninterrupted service during the test. On alternating-current circuits use a standard wattmeter, voltmeter and stop watch, or standard test meter, and on direct-current circuits a millivoltmeter, shunt box, voltmeter and stop watch, or a standard test meter. Use a slide rule for computations. Test meters on approximately 5 and 80 per cent of their rated capacity. The number of meters one tester and assistant can test per day by the above methods varies with the location of meters, but the average, using instruments, is about eight meters per day. The average number per day with the standard test meter has not been determined.

THE PHILADELPHIA ELECTRIC CO.

We find that the most satisfactory method of testing meters on customer's premises is to use voltmeter and standard resistances. In connection with the latter calibration cards are used, giving the seconds of time taken by a certain number of revolutions of the disc. These cards are made out at half-minute intervals. By this method only one instrument has to be read besides counting revolutions of the disc of the meter.

DAVID W. BEAMAN.

For small meters a calibrated resistance box and voltmeter. For other sizes up to 200 amperes, resistance box with ammeter and voltmeter. For meters of 300 amperes and upward, a portable storage battery with ammeter and voltmeter.

Six to eight meters of the usual size per day.

J. W. C., E. E. I. Co., BOSTON.

Our practice is to use a perfectly calibrated instrument in series with consumer's meter, but we only make such tests in cases of disputed accounts. The number per day that might be tested by one man would depend entirely upon the ground which he would have to cover in conducting such tests. J. J. CAGNEY.

Most companies manufacture a special integrating wattmeter for this purpose. Connect the two meters in series and compare revolutions. This method, while thoroughly reliable, is quick and simple and also easily understood by your customer. One man with a system of this kind may test 15 or 20 meters daily.

W. H. GREENSLIT.

Use standard size portable recording meter, or an indicating wattmeter with stop watch. The number tested in a day must vary widely with the location of meters as regards accessibility and the number of meters within a given radius.

RALPH R. LAXTON.

Rotating standards; as the personal element of reading indicating wattmeters and voltmeters is eliminated. Six to ten a day.

E. R. FRENCH.
W. T. OVIATT.
J. J. GAFFNEY.
F. C. S., MALDEN ELECTRIC CO.

U 10. In testing large consumers' meters requiring current transformers, what is best practice—to test with or without current transformer?

In all meters where a current-transformer is used, transformer should be tested periodically as well as the meter, as a slight error in the transformer will make a greater one in the meter. This can be determined by connecting a wattmeter on the primary and one on the secondary end of the transformer.

THE COLORADO SPRINGS ELEC. CO.

Where possible, meters should be tested on the primary side of their transformers in order to include the errors of ratio and drop in secondary currents. DOUGLAS P. MORRISON.

(Concurrent opinions expressed by W. H. GREENSLIT, C. E. INMAN, F. C. S., MALDEN ELECTRIC CO., J. W. C., E. E. I. CO. OF BOSTON.)

U 11. What is common practice in regard to the re-calibration of customers' meters? How often should they be re-calibrated?

This, I think, depends entirely upon the make of meter, whether they are old-type Thomson recording wattmeters or modern-type induction meters. If the old-type Thomson recording wattmeter is used a great deal of the time on light load, test four times a year; modern-type induction meter at intervals of eighteen months, and one year under any conditions.

F. C. S., MALDEN ELECTRIC CO.

The best modern practice calls for the *periodic* testing of meters on the consumers' premises. The length of the period must vary with the locality, business, load connected, *et cætera*, and no general rule can be laid down. Each meter, however, should be inspected once each year. Some will need thorough tests every three months or oftener. DOUGLAS P. MORRISON.

In meters of large capacity where a heavy load is used it is considered good practice to test and re-calibrate meters at least each three months. This applies to theatres, department stores, large power installations, *et cætera*. In the more ordinary cases where fairly large and constant loads are used, a test every six months is considered sufficient.

In all other installations, such as residences, *et cætera*, we test and re-calibrate once each year. All meters are re-calibrated to register within five-tenths of one per cent either above or below absolute accuracy on 5 and 80 per cent loads.

THE PHILADELPHIA ELECTRIC CO.

Commutator-type meters should be tested on customers' premises three times a year. An up-to-date induction meter should be tested once a year by using an indicating wattmeter and applying the ordinary formula; or put a graduated-disc recording wattmeter in series and note the difference in speed of the two discs, keeping in mind the disc constant. E. C. DEAL.

From two to twelve months, depending upon the amount of use. The general rule of a test for every million revolutions of the disc gives good results.

J. W. C., E. E. I. Co., BOSTON.

We test direct-current meters about twice a year and alternating-current meters about every 15 to 18 months.

DAVID W. BEAMAN.

Induction meters should be tested once a year. Commutator type every six to eight months. C. E. INMAN.

Every six months in business sections of territory, and once in eight months in residential districts. J. J. GAFFNEY.

Customers' meters are commonly tested once each year; they should be tested twice each year. W. T. OVIATT.

At least once a year. E. R. FRENCH.

We average once a year except in special cases.

W. H. FELLOWS.

Local laws prescribe re-calibration of meters every five years; and this re-calibration should occur frequently if experience so dictates. J. J. CAGNEY.

U 12. If a meter is correct on light loads, will it be always so on half and full loads?

Not necessarily. The full-load accuracy of the meter is controlled by the position of the permanent magnet, while the light-load accuracy is controlled by the shunt coil. The instrument should be calibrated both upon full and light loads. When this is done it will be found to be practically correct at all intermediate loads. W. R. B., N. Y. ED. Co.

A meter can be calibrated to be correct on all loads, but after constant use it will become slow on light loads but still retain its accuracy on half and full loads. It can then be re-calibrated on light load without changing full load.

THE COLORADO SPRINGS ELEC. CO.

It depends somewhat on the type of meter. In the commutator-type meter, especially some of the older types, in order to get an accurate record on very light loads, meter would almost invariably be fast on full load. The later-type meters have practically overcome this difficulty. I find that in the old-type meters it becomes necessary to allow from 10 to 20 per cent slow on anything less than 50-watt load in order to get an accurate record on from one-half to full load. F. A. JOHNSON.

No, not after long periods of use. Should be checked every three months. On our system the main source of profit to the company is the consumer whose bill is not over $5.00 and he constitutes a large majority. The light-load accuracy of the meter should be very carefully maintained for the small station.

FRANK BECKWITH.

If a meter is correct on light load it will in nearly all cases be correct or slightly fast on half and full load. E. C. DEAL.

Owing to friction materially affecting the accuracy of a meter on light loads, it is possible to have a meter correct on light load and still be 20 per cent off on half or full load.

TOLEDO RAILWAYS AND LT. CO.
E. A. VAUGHAN.

Not necessarily, as a light-load adjustment does not govern the half or full-load accuracy. THE PHILADELPHIA ELEC. CO.
DAVID W. BEAMAN.

Not necessarily; it is difficult to calibrate one so that it will be absolutely correct on all loads. J. J. CAGNEY.

(Concurrent opinions expressed by C. E. INMAN, F. ELLWOOD SMITH, F. O. BROILI, W. H. GREENSLIT, W. H. FELLOWS, H. A. STRAUSS, J. W. C., E. E. I. CO. OF BOSTON, E. R. FRENCH.)

Unless overloaded when properly installed I fail to see why it would not. J. H. ENRIGHT.

U 13. Would it pay a small station having about 500 meter customers to keep a man just to read meters, to keep meters in repair and to test same; and how often should they be tested?

In a station with 500 customers, if the service is alternating and the meters are of the older patterns, I should think one man would have his hands full keeping up the meters and reading them monthly, but with the later models a meter man should be able to do this work easily and have time for other duties as well, such as looking after complaints and possibly some new business. I made it a rule at one time to test meters every six months, then changed to once a year, but for the last two or three years have not had a set rule. By looking after the bills, making comparisons where there is a noticeable difference that can not be accounted for, and in looking after complaints and testing the meters on the installation in question, I think I have got on about as well as formerly. S. S. INGMAN.

We certainly think it would pay. Too much importance can not be laid upon the necessity of keeping meters in good condition. Meters should be tested at least once a year and in special cases where loads are heavy and constant, more often, say every six months. Meters should also be examined at intervals during the year if the amount of current registered for given periods fluctuates—where the cause of such fluctuation is not explained by an irregular use of the light or power.

THE PHILADELPHIA ELECTRIC CO.

Circumstances alter conditions. If a plant can not retain a meter man, I would suggest engaging the services of a good meter man a few months each year, giving all meters a thorough inspection and test. C. C. GARTLAND.

Yes. One man would have all that he could do if the work was done properly, and the increased revenue due to the proper care of meters will much more than pay the cost of testing. Meters should be tested at least once a year, preferably once in six months. W. T. OVIATT.

There is no special question in our mind but that the employment of a man whose specialty would be meter maintenance and reading, would pay in a 500-meter installation, but he ought to have considerable spare time for some other work besides meters. W. H. FELLOWS.

Stations having 300 meters or more should have a distinct meter department. Establish a one-man department for 300 meters and add one man for each additional 500 meters. (See answer to U 11.) E. C. DEAL.

I should think it would pay to have a meter reader for 500 meter customers. He could do other clerical work in connection with this. Keep a separate man for the maintenance of meters. Period of testing is answered in U 11.

F. C. S., MALDEN ELECTRIC CO.

It is desirable that one man should care for all the meters and make that his special business. He could also read the meters and collect some of the bills. F. ELLWOOD SMITH.

(Practically concurrent opinions expressed by T. H. T. & L. Co., THE COLORADO SPRINGS ELEC. CO.)

Yes. Meters should at all times be kept in best condition possible. There is no set time that a meter will run before needing to be tested. Time will vary widely, depending on location of meter and on kind of service supplied through it. A complete record of meters should be kept as to condition, when tested, result of test, repairs made, and so forth.

F. A. JOHNSON.

With 500 meters and reasonable area three men will be required for about three days each month to read, if bills are to be gotten out at about the same time. Your arc-light man should also be able to keep 500 meters in repair and tested.

H. A. STRAUSS.

Yes; 500 meters with entire care and reading, with perhaps the changing, should keep one man reasonably busy.

J. W. C., E. E. I. Co., BOSTON.

Yes. With very much "trouble work," one man would do well to make regular inspection once in three months.

RALPH R. LAXTON.

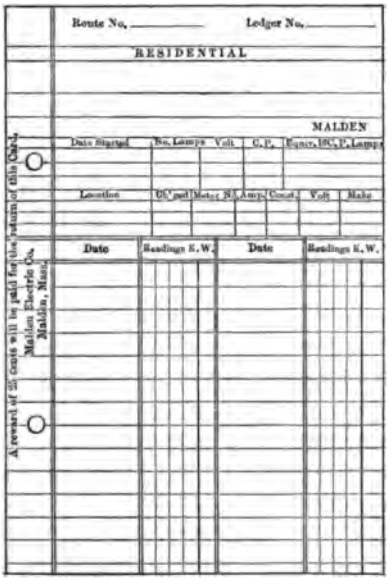
Yes. It would in your small station keep this man fairly busy, and he could in spare time be employed profitably otherwise, as in soliciting, adjusting difficulties, keeping newspapers in line, and so forth. Choose your man with this in mind.

FRANK BECKWITH.

U 14. What is your basis of districting the city in your alternating-current territory? Do you read meters according to your lighting feeders, or do you adopt a purely arbitrary district line?

In a small station, up to about 200 consumers, the meter reading can be taken care of very nicely by plotting the streets on a sheet that will go in the meter book. Make this in ink, and make a dot with a soft lead pencil where there is a meter, so that the mark can be erased and changed as the business demands. The meter sheets should be held in a loose-leaf binder five by six inches. Indexed through the book, alphabetically, each sheet is readily brought to view as desired. With more customers it is advisable to use numbers instead of dots to designate the meters, these numbers corresponding with the customer's number and the meter sheets being placed in the binder in numerical order. Any number of meter books may be used, so long as the numbers on the plot and the meter sheets correspond. S. S. INGMAN.

Our meter reading is laid out in routes. Meter cards are of the loose-leaf form (see accompanying cut), each class of service being printed on different color card. Routes are so arranged that the meter reader has to go the least possible distance from one customer to another to cover the routes. Customers' ledger is also written up in the same order as the meter cards. The meter readers read continuously, so that they get around to the same customers' route at practically the same time in each month. F. C. S., MALDEN ELECTRIC CO.



Route No., ____________ Ledger No., ____________

RESIDENTIAL

MALDEN

Date Started	No. Lamps	Volt	C.P.	Equiv. 16 C.P. Lamps

Location	Ch'ged	Meter No.	Amp.	Const.	Volt	Make

Date	Readings K.W.	Date	Readings K.W.

A reward of 25 cents will be paid for the return of this Card.
Malden Electric Co.,
Malden, Mass.

METER READER'S CARD

All meters read by districts fixed wholly by convenience, without regard to feeders or circuits.

J. W. C., E. E. I. Co., Boston.

In reading meters we follow a district line and from end to end of streets; while one meter book may cover but one long street, another will include several short streets in one district, the intention being that each meter book shall contain a fair day's work for every meter reader. J. J. Cagney.

Each meter reader has a certain route to cover each month, and plans to read the same meter the same day of the month each time. E. R. French.

We adopt an arbitrary route, regardless of feeders.

E. C. Deal.

Our meter readers' books are made up partly according to feeder arrangement and partly arbitrarily, the intention being that each book shall be so arranged as to enable the meter readers to get around as rapidly as possible.

T. H. T. & L. Co.

Errors in reading meters will unavoidably creep in, despite system. Let the bookkeeper carefully note any change in size of bill and hand those back for reading the second time which are thought to be at variance with past records.

Frank Beckwith.

Read meters from right to left, then check readings by reading from left to right; in other words read twice if you would eliminate possible errors. W. W. Fuller.

W. R. B., N. Y. Ed. Co.

We have found very satisfactory the method of having the meter reader mark the position of the pointers on a card that is a fac-simile of the meter dial. By this method the reader does not actually read the meter, but merely draws the position of the hands on the card. The Philadelphia Electric Co.

F. D. Sampson.

Have one make of meters and do not change meter man.

R. N. KIMBALL.

Hire good men and hold them up to a high standard.

J. W. C., E. E. I. Co., BOSTON.

Employ good men. Compare every bill, before sending out, with the customer's previous record; insist upon a careful comparison, and do not hesitate to re-read the doubtful bills.

PERCY INGALLS.

***U 15. What are the best methods to use to eliminate errors in reading meters?**

Have intelligent readers, and do not change them from the regular route. Forms, methods and systems cut very little ice if you have a "bum" reader. I would, however, advise a very simple but properly ruled sheet for each customer and one that will take care of twelve months' readings. Leave a space opposite each month for remarks. Make up loose-leaf books of convenient size from these sheets. Let January reading be at the bottom of the page and place the readings each month one over the other and allow your reader, if he so desires, to carry out the figures showing the difference between the reading of the present and past month. This arrangement enables him to make the subtractions easily, also to detect readily any decided change in the customer's current consumption from that of the previous month. If any decided change is noticed he can re-read his meter while on the ground. This saves time and delays. This system, however, has little, if any, advantage over the method by which the reader is furnished each month with a printed form giving customers' name, address, month and meter number, but no previous reading. With these forms the reader makes up his loose-leaf route book, takes his readings, and turns them in each day by removing such leaves as have been filled out with readings. This method should be known as "grief to curbstone readers."

E. C. DEAL.

(a) Have competent men, thoroughly instructed on meter reading, especially with regard to the relation of dials to each other; (b) adopt one good meter as your standard and avoid the installation of an assortment of instruments; (c) read direct in kilowatt-hours, and adopt a system whereby meter readings will not require to be retranscribed; (d) alternate meter readers' districts every reading; (e) have all meter readings passed through the hands of a competent, experienced man, whose duty it is to scrutinize readings and question any apparent abnormal condition, either in increased or decreased consumption.

J. J. CAGNEY.

I have noticed that some companies furnish their customers with a card that is to be hung up near the meter, on which the meter reading is placed when read, for the convenience of the customer in checking the reading. It is claimed this has a tendency to make the reader more careful. S. S. INGMAN.

Mr. Thos. W. Burke, of Anaconda, Mont., proposes that the meter reader be furnished with a camera and photograph the face of the meter, thus giving a permanent unquestionable record. The face of the meter to bear the name and house number of consumer, the inside of camera hood to contain a card bearing date and name of reader with blank space for last reading and calculation of bill. The camera to be fitted with rolls of sensitive paper, printing by concentrated light of bull's-eye incandescent, or with films for printing from the negative. By this means, if it can be successfully carried out, the meter-reader is checked and any errors of reading or of transcribing figures are eliminated. HERBERT MCNULTA.

***U 16. Would it not do away with many complaints if meter readers would leave a duplicate reading with the customer?**

Yes. The writer prefers to follow the plan of instructing the customer as much as possible. He has in the office a regular meter dial taken from a meter and neatly mounted in a tin box, with an opening in same for the finger to engage the wheels of the dial train, and this meter face is set at different readings and the method of reading at each one shown and explained. Differences between one reading and another are shown and figured in dollars and cents. The customer is encouraged to keep a record of his own readings for comparisons with ours. Then, by having the customer capable through your instructions to roughly test his own meter, many unnecessary, foolish and unjustified complaints are avoided. FRANK BECKWITH.

There are good arguments for and against leaving duplicate meter readings with a consumer. The leaving of a duplicate reading constitutes another liability of error unless the duplicate be a carbon copy (which is not easily obtainable if the original be a loose card or strong sheet intended to form permanent record), and, if a discrepancy between such reading and the account rendered should occur, the possession of such duplicate would form undisputable evidence against the company. The argument in favor of the idea is that present-day practice leans toward the enlightenment of the public, and for that reason the leaving of duplicate readings with consumers would help remove the popular presumption of extortion—so apt to find place in the public mind. If a public service corporation is an honorable one it will not exact from its consumers more than it is justly entitled to, and for this reason it should be quite anxious to acquiesce whenever it is manifestly in the wrong. J. J. CAGNEY.

Only with customers of more than ordinary intelligence. We do not believe that it would assist to any great extent in eliminating complaint with the average customer. It is our practice to leave duplicate dial readings only upon special request.

W. R. B., N. Y. ED. Co.

Unquestionably it would obviate many complaints by unveiling to the lay mind one of the mysteries of an electrical appliance. M. C. TURPIN.

Yes; but if there are many meters to be read it would take so much time that it would not be practicable.

F. ELLWOOD SMITH.

Yes; it often satisfies the customer. W. H. GREENSLIT.

Yes, and every customer should be instructed how to read his meter. A. O. FRETZ.

Not in all cases, as when dial hands are slightly misplaced it might cause the consumer to think the meter has been read incorrectly. It is also considered that a very small percentage of the consumers would avail themsleves of this opportunity to check the bill. THE PHILADELPHIA ELECTRIC CO.

Possibly to some extent, although not a good practice to encourage. J. W. C., E. E. I. CO., BOSTON.

We do not believe the majority of customers care to be bothered with advance information on meter readings.
PERCY INGALLS.

U 17. What has been your experience with direct-current meters for power purposes on 220-440-volt three-wire circuits?

U 18. What are the drawbacks to the Sangamo direct-current integrating wattmeter?

To be answered in executive session. EDITOR.

U 19. What are the principal service troubles with the new General Electric type C Thomson recording wattmeter?

To be answered in executive session. EDITOR.

U 20. (a) In connecting Thomson recording wattmeters are the markings of the connections strictly adhered to in practice? (b) Does meter man carry a voltmeter to determine polarity of wires? (c) Should service connections be changed to bring in wires correctly? (d) What effect will a connection not made according to marking have upon the operation of the meter?

(a) No. (b) Not necessarily. (c) No. (d) In our experience, none whatever. E. A. VAUGHAN.

(a) As a rule. (b) No—a polarity indicator. (c) Not necessarily. (d) None—meter will operate equally as well.
E. A. M., N. Y. ED. Co.

(a) Yes, they should be, as connecting up backward will show an error in record on light loads. (b) Man installing direct-current meters should at all times carry a polarity indicator or voltmeter. (c) Yes. (d) See (a). F. A. JOHNSON.

If meters are tested upon the premises soon after installing, the polarity markings of the manufacturer need not be followed. If such installation tests are not made the polarity markings had better be followed. J. W. C., E. E. I. Co., BOSTON.

(a) Not always.

(b) Polarity can easily be found by using polarity indicator or paper.

(c) Cross leads if positive are on wrong side.

(d) By putting positive wire in post marked negative, the current has to pass through the series winding before it reaches the shunt winding. This slightly affects the registration, but not really sufficiently to matter. A. PETERS.

In connecting Thomson recording wattmeter we pay no attention to the polarity marks on the meter. If the meter is not connected up as marked, it results in some inaccuracy on light loads, and sometimes causes the meter to creep. This error is corrected after the meter is installed, by an adjustment of the starting coil. O. J. BUSHNELL.

(a) Yes, they should be, in order to have the meter register accurately.

(b) No. Use a polarity tester.

(c) No. Cross the wires before they enter the meter, using circular loom if necessary to keep the wires from touching each other.

(d) It will affect the light-load accuracy from 2 to 5 per cent. DAVID W. BEAMAN.

U 21. What methods are used in overcoming the humming of a meter? Have such methods permanent results?

Methods employed to eliminate the "humming" of a meter can have permanent results only where the voltage remains practically constant. BRISTOL GAS AND ELEC. CO.

A hum-retarder can be put on, which will stop the sound completely and permanently if put on carefully. A piece of wire can be fastened to some part of the vibrating frame and to another part of the frame, forming a metallic connection and breaking up or damping the tuning-fork effect. This has been tried in several cases and has proved satisfactory.
THE BROOKLYN EDISON, METER DEPT.

Be sure that all parts of the meter, including the cover, are tight and then, if necessary, place a drop of oil in the top bearing.
J. W. C., E. E. I. CO., BOSTON.

Humming is usually caused by the laminations becoming slack. Tighten up. A. PETERS.

The humming of Fort Wayne meters can be stopped in almost all instances by equipping the meter with the new flexible top-bearing stud. O. J. BUSHNELL.

Use solid support, as the outside wall in cellar. Soft rubber placed back of meter will often absorb the vibration and reduce the humming. C. E. INMAN.

U 22. What has been the experience of lighting companies in cities of from 50,000 to 150,000 inhabitants in regard to exacting deposits?

Deposits are very necessary in growing cities to protect business. The requirement is somewhat galling and we call it "an estimated payment in advance."
BIRMINGHAM RAILWAY, LIGHT AND POWER CO.

U 23. In testing meters should tests be made at light, half and full loads, and the average taken?

It is necessary to test meters on light and full loads only; if they are made O. K. on these loads they will very seldom change at intermediate points.

THE COLORADO SPRINGS ELEC. CO.

Test meters at fractional loads. In connection with disputed bills, test at load customer claims to use. You will make a hit, provided your meter is a modern one. F. D. SAMPSON.

Yes, unless the future load for the meter is known, when it should be adjusted with special reference to that particular load.

H. D. LARRABEE.

No. Let each load test stand by itself. C. E. INMAN.

Tests should be made at 10 per cent steps and average taken if average will compare very nearly with load average on meter; if not, then some allowance should be made in case the meter has just been taken out of service to ascertain correctness of same. In re-calibrating meter an average of all readings should prove correct. F. A. JOHNSON.

It is good practice to test meters on one-tenth and one-half loads. O. J. BUSHNELL.

Two points sufficient, either light load and full load, or light load and half load, but averages not to be taken.

J. W. C., E. E. I. Co., BOSTON.

Meters should be tested upon full load, or as near full-load capacity as possible, and also upon light load or one-tenth of the full-load capacity. If the meter is calibrated correctly upon both these loads, it will be found to be approximately correct at all intermediate loads. W. R. B., N. Y. ED. CO.

U 24. Is it better to put a meter in each phase of a two-phase motor circuit or to use a polyphase meter?

It is better to use polyphase meter, but care must be exercised that potential is taken from the proper phase, otherwise meter will not register correctly; it registers to total load on one dial and will always run forward if connected properly.

THE COLORADO SPRINGS ELEC. CO.

Use a polyphase meter. Two meters will give the energy consumed; however, you will find that each meter does not record half of the total. Customers sometimes notice this, then complex explanations are in order. F. D. SAMPSON.

There is but little difference, as the polyphase meter is virtually two single-phase meters in the same case.

H. D. LARRABEE.

Use a polyphase meter. E. C. DEAL.

J. W. C., E. E. I. CO., BOSTON.

O. J. BUSHNELL.

RALPH R. LAXTON.

Meter in each phase. A. PETERS.

U 25. (a) Suppose that a building wired on the three-wire Edison system is connected to a four-wire, three-phase distribution for lighting service with 115 volts between the neutral and any one of the other three wires and 200 volts between any two of the three-line wires. The service wires to the building would be connected with the neutral on the line and with two of the outside wires, making a three-wire connection with 200 volts between the outside wires and 115 volts between line and system. Will an ordinary Edison three-wire meter register the service correctly or will it be necessary to install two single-phase meters with 115-volt potential windings? (b) What will be the error with the three-wire meters?

Ordinary three-phase meter will not register correctly, because of improper phase relations between current and potential.

J. W. C., E. E. I. CO., BOSTON.

O. J. BUSHNELL.

Don't think either would measure correctly. The proper arrangement would be three single-phase meters with their current coils in their respective phases, and potential coils connected between the respective phases and the neutral.

RALPH R. LAXTON.

U 26. Why does one meter register more than the other on two-phase circuit for a single motor?

See explanation in measurement of power in alternating-current circuits in any modern standard handbook—Foster's, for instance, or works by Jackson, Thompson and others.

F. D. SAMPSON.

The voltage on one phase must be higher than that on the other. W. P. SCHWABE.

Because of load being unbalanced between phases.

J. W. C., E. E. I. Co., BOSTON.

One phase of motor is taking more current than the other. This may be caused by defective construction of motor or by system being unbalanced. E. C. DEAL.

Low power factor. RALPH R. LAXTON.

A fuse may blow on one phase and the motor be run by the other phase for a time. Have known a motor to run for several hours on one phase. WALTER FLINT.

U 27. In metering current for a two-phase motor, a separate meter being placed on each phase, what methods are used to prevent reverse registration on either meter due to power factor? What method is used in billing an account with such reverse registration?

If power factor is above 50 per cent and meters are connected right, they will always run forward, but should one run backward the reverse reading should be deducted from the high reading billing for the balance.

THE COLORADO SPRINGS ELEC. CO.

The backward registration of one of the meters should not be prevented, but the algebraic sum of the two meters be taken. Remedy should be applied to the motor rather than the meters. In billing, show the algebraic sum of both meters rather than of each separately. J. W. C., E. E. I. Co., BOSTON.

O. J. BUSHNELL.

Motor should not have so bad a power factor as to cause reversed registration except possibly at moment of starting. Polyphase meter would help matters. RALPH R. LAXTON.

U 28. Will a 220-volt, two-wire, direct-current meter record accurately on a 220-volt, three-wire circuit?

Not unless the load is evenly balanced, which is very seldom the case in incandescent, 110-volt lighting. E. A. VAUGHAN.

O. J. BUSHNELL.

Not without making changes in field connections and shunt circuits. E. A. M., N. Y. ED. CO.

No. A two-wire meter registers current in only one leg of service. A three-wire meter registers the current in each of the outside wires. A. PETERS.

The meter must have a current coil connected in each side of the line to record correctly when used on a 220-volt, three-wire system. B. C. ADAMS.

J. W. C., E. E. I. Co., BOSTON.

U 29. Are polyphase meters in a state of experiment, or is there any weakness in them? Why are they not in general use, or why is it that large companies have not adopted them?

We have no trouble whatever with these meters for motor service, using them in capacities from 10 to 200 amperes, 220 volts. H. D. LARRABEE.

Polyphase meters, both indicating and recording, appear to be well past the experimental stage. Think you will find upon investigation that large companies are using them extensively.

RALPH R. LAXTON.

Our company is operating a hydro-electric plant and furnishing twelve cotton mills with an aggregate of 7500 horse-power. All contracts are made upon kilowatt-consumption-per-month basis, and all this energy is measured and recorded by polyphase meters on circuits of 550, 2200 and 11,000 volts. We find them quite correct, having used them with other instruments to verify their correctness of reading. F. D. SAMPSON.

Polyphase meters are in general giving very good results.

J. W. C., E. E. I. Co., BOSTON.

Polyphase meters are used by the Chicago companies and give good satisfaction. O. J. BUSHNELL.

U 30. Electric meter manufacturers claim that meters will stand 50 per cent overload for a short time; is it not true that electric meters will carry overloads much in excess of what manufacturers claim for them?

We answer this question by citing an instance in our experience which came to our notice as recently as March 28, 1906. On that day we removed in good condition and installed elsewhere a 5-ampere, 110-volt, General Electric, form D. F., induction meter, which had been installed August 13, 1903, nearly three years previously, in a church, with a connected load of fifty-four 16-cp lamps, equal approximately to five times the normal capacity of the meter. This meter had undoubtedly carried that entire load many times for periods of two or three hours' duration. It was in good condition, but running about seven per cent slow at largest load and at full normal load. Its record showed that it had once been brought in for test during that time and reinstalled without the "bust" being discovered.

W. H. THOMSON, JR.

Some meters will stand 75 per cent overload, but will not register correctly or uniformly above 10 per cent overload. Best results at rated capacity. E. A. VAUGHAN.

Yes; they seem to be able to carry 100 per cent overload for a short time. However, the danger of burnouts is not so great as the danger of injuring the meter magnetically, thus changing the calibration. H. D. LARRABEE.

Some electric meters will stand 100 per cent overload continuously, whereas others will not stand as much as 50 per cent overload, depending upon the make and size of the meter. Manufacturers are generally conservative in giving the overload capacities of meters, and it is right they should be, as meters are affected considerably by the conditions under which they are installed. O. J. BUSHNELL.

The average meter is rated to carry 50 per cent overload continuously, and therefore will carry more than this amount for a short period. A. PETERS.

Some meters will, and all *should*, carry 100 per cent overload for a short time. B. C. ADAMS.

Yes, so far as burning out of the meter is concerned, although poor practice for the good of the meter.
J. W. C., E. E. I. Co., BOSTON.

Yes. C. E. INMAN.

U 31. What size meter would you advise for use on building containing 100 16-cp lights, one-fourth of same being in use about nine-tenths of the year?

A 15-ampere meter would be large enough for this installation. THE COLORADO SPRINGS ELEC. CO.

A 15-ampere, 220-volt, three-wire meter would be considered correct. THE PHILADELPHIA ELECTRIC CO.

This depends upon the maximum number of lights being burned at one time. Determine the maximum load and allow for a continual 25 per cent overload, or a one-hour 50 per cent overload, and install meter accordingly. E. C. DEAL.

Probably a 15-ampere meter, although somewhat indefinite because of no statement as to the manner of burning of the remaining three-fourths of the lights connected.
J. W. C., E. E. I. Co., BOSTON.

If two-wire service, and all lights are used at times, place 30-ampere meter. If three-wire service, 15-ampere meter.
A. PETERS.

A meter of from 50 to 65-light capacity, depending upon the make. O. J. BUSHNELL.

Thirty to 40 amperes. C. E. INMAN.

For a two-wire system, a 20-ampere meter is advisable. It will carry the entire load at times and the ordinary load accurately.

For a three-wire system, a 10-ampere, three-wire meter will handle the load in good shape. B. C. ADAMS.
C. H. CUSHMAN.

U 32. What investigations should be made by meter testers? Should they endeavor to ascertain the load used, recount the connected load, etc., or should this be done by a separate department?

If meters are tested on the premises with the house load, the meter tester should make such investigations. He can then report to the meter department, who will know if it is desirable to change meter.
THE COLORADO SPRINGS ELEC. CO.

Meter tester when testing on premises should count connected load, examine connections to see that all load is back of meter, note whether meter has been tampered with. Making these examinations by another department increases annoyance to consumer. HERBERT MCNULTA.

Most customers object to admitting different men into their houses. The meter tester should make test on full load of meter. He should also get any other information necessary, also point out to the customer why his bills are high, if possible.

W. P. Schwabe.

It seems advisable to have the meter tester adhere strictly to the testing of meters. He is supposed to be an expert in this line and should not be troubled with making surveys of the installation. In making a test of a meter, however, should he find that the same is overloaded it should be immediately reported so that it may be changed if considered necessary. Ascertaining the load and surveying the installation should, we believe, be taken care of by separate department, which should keep a complete record of the same. W. R. B., N. Y. Ed. Co.

Unless testing with particular reference to customer's complaint, the tester should confine his efforts to the meter or to such conditions as may exist between the meter and the service.

J. W. C., E. E. I. Co., Boston.
O. J. Bushnell.

In smaller stations (up to 2500 meters) this can be taken care of very well by meter department. C. E. Inman.

Meter testers should recount connected load and should ascertain if all lights are on meter. G. H. Cushman.

The load records, *et cætera*, could very well be kept by meter departments, as this department is generally in better position than any other to verify records. Ralph R. Laxton.

U 33. What is the cost of meter maintenance on a 3000-meter installation that is kept up in good shape? Thomson recording wattmeters and induction meters used.

It costs us about $4000 per year to maintain about 3000 Thomson recording wattmeters and induction meters. We have

recently found it necessary to add another crew of meter testers in order to test the meters often enough to keep them accurate.
UNITED ELECTRIC LIGHT CO.

U 34. In a city having 9000 meter customers, which is considered the better method to read meters: large force of readers during last few days of month, or divide city into districts and take readings on, say, tenth, twentieth and thirtieth of month?

We would consider dividing the territory into districts the better on account of eliminating a rush of work at the end of the month. Under this method the substantial increase in business, which is to be expected and is more readily handled, prevents the necessity of changing the system, which would seem to be inevitable at some future date. THE PHILADELPHIA ELEC. CO.

Read meters every day in the month, except Sundays, and render bills accordingly. Fix the same date each month for reading a certain meter. E. C. DEAL.

Continuous readings by a small number of men.
J. W. C., E. E. I. Co., BOSTON.

U 35. What has been the experience with companies with regard to prepayment meters?

With the Wood prepayment device we find that the coin box is not large enough to run a month where the current purchased amounts to $12 or $15. The same point applies to the Westinghouse device. With the Wood device we find that at times the credit wheel will run too far and coins can not be inserted until it is rewound. Otherwise satisfactory. F. M. VANDER VOORT.

The best method of obtaining a check on work of solicitors is the use of daily reports on printed forms; examine such reports carefully and if relating to unfinished business, file under the future date on which the examiner wishes to have the subject again introduced. As the business is completed file all reports together with memoranda, letters, *et cætera*, under street numbers, bearing the name and nature of business. A cross index showing same address under name of the consumer should be used in conjunction with street-address index.

THE BROOKLYN EDISON, E. W. PHILLIPS.

U 36. How do you keep record of meters from the time they are received from factory until they are disposed of as useless?

Each meter on its purchase should be given a company's number and badged with a metal badge attached to the case, and bearing this number. A meter record book should be kept; giving the company's number, manufacturer's number and the necessary data regarding the type and capacity of the meter. Every meter should retain the company's badge until condemned or destroyed, when the badge should be removed and filed, not being used again. Every meter should be accounted for in the record book, either as set, in stock, away for repairs or destroyed. With the meter badges on hand, this will account for the total number of meters. A. T. BEAUREGARD.

Use the card system—one card for each meter. The cards are numbered consecutively to correspond with given numbers of the meters, not the factory numbers. On each card is space for the factory number of the meter, make, constant, size and date received. On this same card, space is ruled to contain a number of tests, dates of the same, by whom tested, location of meter, when tested, and changes made in re-calibration.

DAVID W. BEAMAN.

By numbering card. One side has date of invoice, description and record of installation. Reverse side, record of tests and repairs. C. E. INMAN.

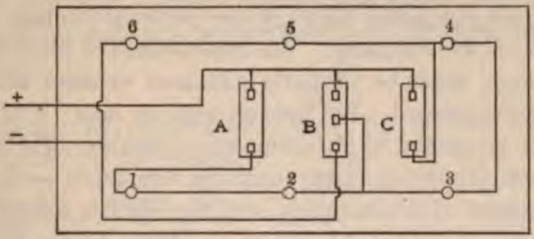
When a meter is received in our storeroom from the factory a history card is made out and the details are entered from time to time as to changes, locations, repairs, *et cætera,* this card is kept until such time as the meter is junked.

T. H. T. & L. Co.

(Practically concurrent answers received from E. C. DEAL and THE PHILADELPHIA ELECTRIC CO.)

U 37. Describe a convenient portable load device for meter testing.

A very convenient and easily portable load device can be formed from six porcelain resistances. These can be mounted between two sheets of one-fourth-inch fibre and held together by four one-quarter-inch iron rods and the switches mounted on the top. The arrangement is shown in the sketch where 1, 2, 3, 4, 5, and 6 are the resistances connected in series, *A* and *C* are single-pole, single-throw, and *B*, ditto double-throw, switches, connected as indicated. They give a combination of five loads, varying from all resistance in series to three groups of series multiple. The most convenient element to use is a tube of 10-ohm resistance, which will give, therefore, at 100 volts, one and two-thirds, 2.5, 5, 10 and 15 amperes.



CONNECTIONS OF PORTABLE LOAD DEVICE

Other combinations can be made with different tubes. Such a device is most useful as a load for testing meters, and will give from one to two years' continuous service. It can be improved by including one 16-cp lamp for light loads.

DOUGLAS P. MORRISON.

V—ADVERTISING

***V 1. What advantages are to be gained by a commercial department, and why?**

An electric company without a commercial department is like a factory without a sales department or a store without counters. It will sell only such goods as the public automatically come and demand of it. The best interests of the public and the company are mutually served by the annual sales being as large as possible per dollar invested. By this only can the price be as low as possible and the gross and net receipts as large as desirable. To accomplish the saturation of the territory thus implied, the public must be educated as to the other means of using electricity profitably to itself. This can be done through the commercial department. Furthermore, a properly-run commercial department will establish a close personal touch and relation with each present or prospective customer and will see that each customer is finally convinced that the company is doing everything in its power to serve him. In this way each customer can be made a supporter of the company. W. H. GARDINER, JR.

The advantage of a commercial department means increased business if properly conducted; the creating and holding of the good will of the public through the personal contact with representatives of the company. The representative must be the right type of man, must be properly educated to meet and talk with the public in general. By "proper type of man" it is meant that he should be awake to the company's interest. He can only be "awakened" by the company treating him fairly—educating him to the business of the company, and the officials setting the example. JOHN CRAIG HAMMOND.

***V 2. What relation should the commercial department bear to the other departments of the company?**

The public lighting business consists essentially of three subsidiary departments, the physical department, the commercial department and the financial department, all of which are under the management.

The physical department is concerned with installing and maintaining the physical equipment and with producing and physically distributing the means of service. In my estimation the commercial department should not merely be the new business department, but should have absolute and entire charge and control of the disposal of the entire output of the company and should be the only department of the company with which the public in any way comes in contact. It should have entire charge of all relations between the company and the public. It should include the meter readers, inspectors, appliance salesmen, district representatives, solicitors, specialty salesmen, complaint department, application department, contract department, claim department and all departments having anything to do with the customer's bills, including the ledger department. It might seem that this last department had best be under the financial department. However, it is of the utmost public importance that this department be so operated as to give the most careful, prompt and satisfactory service to the public. This is much more difficult to accomplish than it is to operate this department in an efficient, economical and financially accurate way as to its audits, checks, and so forth. In my opinion, therefore, the ledger department, together with the collectors, cashiers, *et cætera*, should be under the management of the commercial department, being operated, of course, in a manner entirely satisfactory to the treasurer and auditor; auditor's reports and receipts being daily made to the treasurer. "X."

The commercial department should be in close touch with every department of the company. They should meet and know the engineer, the stoker, the lamp man, the bookkeeper. The representative should be on the lookout for new suggestions to give other departments. If the proper spirit exists among the employees of the company, the man who strings a wire will be glad to know the man "hustling" for more business. Joint meetings, personal investigations and visits at least twice a month will bring the desired results. JOHN CRAIG HAMMOND.

***V 3. Should a gas and electric company push the sale of gas engines or electric motors?**

Push the sale of motors, as people will pay the difference in cost of running for reliability and convenience, and the electric department needs long-hour business.

R. N. KIMBALL.

Gas and electric companies should not hesitate about going after light and power business with an individual interest when both products are at hand, and should submit the two propositions that the customer may decide his wants rather than the company dictate a decision. C. C. GARTLAND.

Push the sale of electric motors. J. J. CAGNEY.
LUDWIG KEMPER.

Best results can probably be obtained by pushing the sale of both gas engines and electric motors. PERCY INGALLS.

Preferably electric motors at any point within reach of the lines. They are safer, cleaner and altogether calculated to give the customer better service than a gas engine.
RALPH R. LAXTON.

***V 4. What effect, if any, does the commercial department have on the market values of electric and gas stocks of companies having such departments?**

The effect of a commercial department is not appreciable on the market. J. J. CAGNEY.

The effect is good or bad, depending on whether the commercial department is efficient or inefficient. If it is not efficient the bad effect is approximately proportional to the expense caused by the department. If the commercial department is really efficient its beneficial effect upon the securities is out of all proportion to the expense, because an efficient commercial department can make more dollars net per dollar of expense than any other department in the electric business. On the other hand, to organize and maintain a really efficient commercial department is one of the most difficult tasks in the business. W. H. GARDINER, JR.

The earning power of the company, the field, the chance to increase the output, the fixed charges, become the basic principles of the value of the stock. A commercial department will increase the business and as a result the value of the stock is so much greater. The local stock or bondholder can't help taking in some of the spirit of hustle and progress of the proper representative. He has more confidence in the company as a result—more confidence if the department is showing results.

JOHN CRAIG HAMMOND.

***V 5. How do the reports of companies having new business departments compare with reports of companies without such departments?**

***V 6. Name the cities in the United States where electric light companies have a regularly organized commercial department.**

New York, Brooklyn, Philadelphia, Chicago, Boston, Buffalo, Denver, and practically all of the principal cities, have regular organized commercial departments. J. J. CAGNEY.

***V 7. How much is an electric light company justified in spending for the securing of new business per dollar of revenue thus secured?**

About two per cent of gross revenue. P. H. KORST.

This depends on the longevity of the business secured.

Assuming a five-year average, it may be conservative to spend in the commercial department, to secure new business, one-fifth of the net revenue realized from the business the commercial department obtains. This would make the expense of the commercial department equal to all the net revenue from the first year's net receipts from the business it obtained, the remaining four years' net receipts being actually realized as net. This commercial department expense is entirely apart from investment and equipment charges and expenses and costs necessary to render service.

W. H. GARDINER, JR.

A company might be justified in spending 50 per cent of the gross revenue at certain times under certain conditions. One per cent under other conditions might be more than enough. To spend 50 per cent of the gross for one month would stagger most central-station men. Howbeit, there are cases where such a move would come under the head of sound business. The possible business must govern the outlay. If there are 500 or 5000 non-consumers and each non-consumer could be made to spend $20 a year with the company, spend $5.00, $10, even the entire $20, if conditions are such that you are sure to hold the business for the second month or the entire year.

JOHN CRAIG HAMMOND.

The proportionate amount will vary according to the territory and local conditions. An average expenditure of 10 per cent of the annual return from the new business secured is reasonable. Much new business can be secured at less expense, but each additional block of new business will involve a proportionately higher cost. The wide-awake company will go after all possible business of a reasonably permanent character. Where necessary, a company could probably afford to pay as high as 50 per cent of the annual returns for business that is expensive to secure, but this would be an extreme figure.

THE BROOKLYN EDISON, W. W. FREEMAN.

V 8. What percentage of your gross receipts do you find it advisable to expend for your total advertising appropriation, including your bulletin and publicity expenses and your regular advertisements?

There are no two cases alike. Some department stores set aside two per cent of their gross for advertising; that is a fair average—some more, some less, however.

JOHN CRAIG HAMMOND.

V 9. Give the percentage of the total amount appropriated to be devoted to each of the different ways of securing new business.

Sixty per cent spent on personal solicitation is about the right average. Forty per cent spent on the proper kind of advertising will assist the soliciting force. The two must work together—one without the other will not show as good results as if combined, and a campaign of co-operation is laid out. A mail advertisement should be followed by soliciting; so should newspaper copy be followed by a personal visit. Hit the iron while it is hot; keep the iron hot and keep hitting.

JOHN CRAIG HAMMOND.

V 10. Assuming an annual advertising appropriation of from $5000 up, is it better for a public-service corporation to lay out its own advertising campaign in its own office in view of local conditions, or is it better to place the matter in the hands of some advertising concern of recognized ability?

There should be no reason why your advertising manager, if he has taken a good course in the profession, should not be fully as competent to plan a good campaign, if not more so, particularly so in view of his thorough knowledge of local feeling—a qualification seldom possessed by experts or concerns far removed from the city involved. J. J. CAGNEY.

It is advisable to employ an outside advertising concern having experience in the electric field unless the appropriation is large enough to support a competent advertising man with necessary assistants; $5000 per annum would just about pay the salary of a fair man and the incidental running expenses of his department. FRANK B. RAE, JR.

The employment of an advertising expert or advertising concern of recognized ability is advisable, provided they be employed primarily in a consulting or advisory capacity. The policy of putting the execution of an advertising campaign into their hands is open to question. "X."

If an advertising man had $5000 to spend for a motor it would certainly pay him to give a portion of the money for the advice of an expert electrical man. So it is with the central-station man. He may know how to write bright things—may have good ideas for copy—but the advertising expert knows more from experience. The central-station man has common sense—let him use that. There is good advice—bad advice. Certain things appear bright and clever to him; they may be costly brightness. No advertising expert can give the same advice to every central-station man. He must submit a list of questions; he must understand local conditions before he can carry on the proper work.

JOHN CRAIG HAMMOND.

If the public-service corporation can secure the exclusive services of an advertising man of equipment, experience and ability by hiring such a man, organizing its own advertising department and conducting its own advertising campaign out of its own office, the corporation is, in my judgment, far more likely to achieve profitable and satisfactory results.

Such an organization is certain to be more in touch with the business, to grow closer to it, in comprehension and expression, than an essentially foreign agency, the primary allegiance of which is due not to the public-service corporation, but to the outside advertising concern. The situation is no different from what it would be if it affected the highest executive offices of the corporation. To conduct the general management or the operating superintendency of the company we should not consider for a moment the proposition of hiring an outside agency (however expert) whose energies and responsibilities were scattered over a number of enterprises. No, we must have our general manager and our chiefs of operating, contract and meter departments always on the spot, where they grow to be part of the life of the corporation, familiar with its past history and its present needs, aware of its possibilities and limitations, prepared for special situations or emergencies as they may arise, impregnated with the local atmosphere and with the enthusiasm and loyalty of the service.

The advertising department of a highly organized and well-regulated public-service corporation should be one of the most important factors in its business existence, for the function of such a department should be not only to sell current, not only to inform and educate the public and to popularize the service by demonstrating its superiority and familiarizing people with its various uses, but it should also have largely in charge, through its newspaper connections, the public-opinion relations of the corporation to its constituency; that subtle, close and delicately poised relationship, the immense significance of which is but now beginning to be fully realized. In other words, the advertising manager should be not only a star salesman, but, in co-operation with the executive officials, he must be the custodian of the company's reputation and of that very real asset, the public good-will.

This function, in the nature of things, no outsider can adequately administer. It requires a man of discretion, understanding and constructive imagination, with mind and purpose singly devoted to the service of the company. The central station that can afford an A-1 advertising man has no business with syndicate services and advertising agencies.

THE BROOKLYN EDISON, M. S. SEELMAN, JR.

V 11. Do you believe that the National Electric Light Association could advance the interests of its members by establishing an exchange of advertising literature? If so, what practical plan can you suggest to carry out this idea?

Yes; and the simpler and more automatic plan would be to instruct all members to forward to a central bureau specimens of all advertising work or matter contemplated, undertaken or issued, or such as might come before them from time to time; the same to be published in pamphlet form, one issue for each season, and mailed to members. Discretion, of course, should be exercised to see that the matter published is applicable to the season. J. J. CAGNEY.

I most certainly do. First, companies are enabled by the interchange to select good ideas that would be of an advantage to use. It seems to me that this plan could be carried out by appointing some member to take up the matter of obtaining all advertising literature and ideas from the different companies and having same classified as to the different branches the advertising covers; that is, power, incandescent lighting, arc lighting, decorative lighting and heating, so that companies could obtain copies of such as they might wish.

F. C. S., MALDEN ELECTRIC CO.

No: the exchange of advertising literature would lead to a promiscuous appropriation of an individual piece of matter without regard to sequence in a regular advertising campaign. The use of such disjointed material is acknowledged to be poor advertising policy. FRANK B. RAE, JR.

Yes, but I am not prepared at present to advance a plan comprehensive enough to cover the ground. L. W. EMERICK.

I think the electric lighting interests would be very much benefited by the establishment of an exchange of advertising literature. Would suggest that an annual, semi-annual, quarterly or monthly periodical be gotten out by the association, all member companies being asked to file with the association copies of all advertising matter as soon as same may appear.

W. H. GARDINER, JR.

Beyond any possible doubt. It would be of the greatest value to every member. There would be the danger, however, of some manager accepting the experience of a fellow manager that may have been a success. It does not follow that it would be a success in his city. His common sense, the advice of some one at the head of the bureau, would be of the greatest assistance. To suggest a practical plan would consume too much space. The plan could be better secured by selecting a committee—the complete discussion of the score of vital points that would present themselves. JOHN CRAIG HAMMOND.

An exchange for advertising literature should be of great value to the members of the National Electric Light Association. There are a great many central stations that could utilize follow-up systems of advertising as well as newspaper advertising to great advantage, but have not at the present time the facilities to conduct an advertising campaign. If an advertising committee were appointed by the association to pass upon the various newspaper advertisements and novelty mailing cards, circular letters, *et cetera*, issued by companies at present doing advertising, they could sift out and select the best of these advertisements, could purchase the designs and original cuts from the companies using them and the smaller companies could purchase electrotypes and copy at a comparatively small figure from the association. The printing of the mailing matter could be done in the various cities and towns in which the central stations were located, or the association could make arrangements for the printing of such advertising.

There could be no objection upon the part of lighting companies using such cuts for advertising, inasmuch as the member companies are in no sense competitors and the advertisements that have proven successful for one company might very well prove successful for another. THE PHILADELPHIA ELECTRIC CO.

V 12. Is there any objection upon the part of lighting companies to using cuts or advertising that have proven successful with other companies?

There should be no objection whatever to a mutual and free exchange of cuts or matter between central stations operating in far separate fields; the lighting business is an entirely local one, and the prosperity of one company can not harm that of another located perhaps several hundred miles distant.

J. J. CAGNEY.

Except as suggested above, under V 11. Such material loses three-quarters of its value because used in disconnected manner. In the case of using cuts, the tendency is to write an advertisement around the cut, whereas the only successful way to compose advertising is exactly the reverse of this method.

FRANK B. RAE, JR.

I do not see where there would be any objections on the part of lighting companies to using cuts or advertising that had proven successful with other companies, unless it would be where they were competing electric lighting companies in the same city or town. F. C. S., MALDEN ELECTRIC CO.

See our answer to V 11.

THE PHILADELPHIA ELECTRIC CO.

No; it is common practice—it saves gray matter and dollars and does not harm the other fellow if you are located far enough away. H. A. STRAUSS.

I can see no real business objection, excepting, perhaps, that the public might notice the interchange and erroneously infer "trust" conditions. W. H. GARDINER, JR.

Yes and no. Yes, if they will "fit" into the local campaign; yes, if they are to be followed up from week to week. No, if one "cute" cut is used and not followed up. Local conditions must govern entirely. JOHN CRAIG HAMMOND.

No. R. N. KIMBALL.
F. ELLWOOD SMITH.
W. W. FULLER.

V 13. Can not a syndicate electric bulletin be employed by central stations to advantage?

No; local conditions vary to such an extent that such a bulletin would be manifestly a "patent sheet"; and, again, the syndicate plan would preclude your presenting the pertinent points most helpful to you. J. J. CAGNEY.

Yes; it is already being done successfully. The only question being that of quality of the bulletin. FRANK B. RAE, JR.

Certainly. It must be broad—much broader than the usual bulletin. JOHN CRAIG HAMMOND.

Yes. F. ELLWOOD SMITH.

A syndicate bulletin might be employed to advantage by central stations, provided but part of each local issue of the bulletin were syndicated. The items of local interest are of great importance in bulletins. W. H. GARDINER, JR.

The small central station that is not able to afford a bulletin of its own, can doubtless use a "syndicate electric bulletin" to advantage—at a price. But the price must be low and the bulletin especially well conducted; otherwise the money can be better expended in purely local advertising.

The above applies to the small station only. The day when elementary, general, hit-or-miss, blanket advertising could be effectively utilized by the central station in any large city, in the opinion of the writer, is over. Each city of any size has its idiosyncrasies, peculiarities, special conditions. To meet these intelligently requires insight, discrimination, judgment, and intimate knowledge of the situation. The advertising of a large central station often means the expenditure of considerable sums, and of these that for the bulletin is usually the heaviest. The text and illustration of such a bulletin must have special relevancy to local conditions and local happenings or the bulletin loses 75 per cent of its efficacy. What would be appropriate and profitable for New York, might not suit New Orleans at all. Advertising that would sell current in Detroit or Chicago might fall still-born in Boston or Brooklyn.

It doesn't make any difference how "smart" the syndicate advertising may be. Successful advertising is advertising which sells the goods, and the writer has known many cases where the plain business-like announcement, the clear, clean-cut statement of a specific proposition "pulled" more effectively than the "smart" agency advertisement, ten to one.

Specific propositions to meet specific situations and announcements that fit the special conditions of the locality—these are the needs of central-station advertising after it has once passed the elementary stage.

THE BROOKLYN EDISON, M. S. SEELMAN, JR.

V 14. What is the best method of advertising for (a) signs, (b) power, (c) store lighting, (d) residence lighting?

There is no best way. Local conditions and the size of the appropriation govern. It is advisable to take up different methods of advertising in the following order:

1. Circular letters addressed to selected lists.
2. Mailing cards, folders, etc., interspersed between such letters.
3. Newspaper advertising, except for power.
4. Display room.
5. Street-car cards.

6. Billboards and other similar methods of general publicity. Programmes and similar petty advertising grafts should not be charged to advertising expense, but to charity.

FRANK B. RAE, JR.

Neat and well-written follow-up letters, varied from time to time by different letter-heads and paper, and an occasional bulletin or folder, preferably illustrating the point to be brought out.

E. A. M., N. Y. ED. CO.

(a) Put up your own electric sign first and make it a good one.

(b) Personal solicitation by a capable man who can figure probable amount of monthly bills in advance.

(c) (d) See (b). H. A. STRAUSS.

Signs, a general newspaper, letter, card and booklet campaign with personal solicitation first. Power, personal letters only as far as advertising goes—unless in cases of where the power prospects amount to more than 1000. Personal solicitation is best for power. However, progress can be made if representative will give to advertising department material and data for an intelligent follow-up letter campaign.

Store lighting same as sign campaign. Residence lighting same, only in a more limited way. It is folly to spend as much money or to send as much mail matter to secure a porch-light consumer as to secure an electric-sign consumer.

JOHN CRAIG HAMMOND.

Don't differentiate—the same general methods that are effective in placing signs will sell power, store lighting and residence lighting. First educate your public up to the advantages of an electric service, make them all "hanker" after it, then bombard them with specific propositions.

Take sign advertising, for instance. Secure the best possible list of prospective sign customers. Send out such striking, attractive and logical sign circulars, folders or booklets, that the man who receives and reads them must be convinced of the advertising effectiveness and the business value of the electric sign. Then follow up with your specific sign proposition; make the store-keeper the best offer you can and couch it in the most alluring terms. Nine chances in ten you'll land him. To secure the best results from this kind of advertising there must be full co-operation between the advertising and the canvassing departments.

The same method of advertising holds good for the other branches of the business.

One essential of such advertising, worth stating here, is this: Never send out a piece of advertising without annexing or including a return post card, addressed to the company, so that all the customer need do to indicate his interest is to fill in his name and address and mail the card. In Brooklyn on many of these return cards, we even fill in the customer's name and address for him. The first principle of political economy is that man is a lazy animal, and with this in mind, we try to simplify the way to inquiries and returns by removing every possible obstacle from the path to our front door. This return-card system has worked excellently in the advertising of the Brooklyn company.

THE BROOKLYN EDISON, M. S. SEELMAN, JR.

V 15. Should not a certain proportion of advertising matter issued be devoted to educating old customers to increased use of current?

Yes; it can be done most economically by means of enclosures with bills, and by special displays in the show-room at times when customers come to pay their bills. About one-quarter of the advertising appropriations should be used in this way.

FRANK B. RAE, JR.

Certainly; because that class of new business which involves little or no expenditure to procure is the most desirable.

J. J. CAGNEY.

Yes; increased use by an old consumer is worth more than a new consumer, as no additional investment is required.

R. N. KIMBALL.

Yes. E. A. M., N. Y. Ed. Co.
F. Ellwood Smith.
P. H. Korst.
W. E. Ryder.

This depends very largely on the rate system used. If an individually equitable differential rate is used, then emphasis should be laid upon acquiring new customers, as under such a system old customers can to a certain extent be relied upon to increase automatically their use of service as this automatically reduces the average cost per unit to them, but if the rate system used is essentially a flat and uniform rate by meter, great pains should be taken to educate and develop old customers to use current in every possible way, without undue elevation of the peak, for thereby only can the retail and short-hour burning customers be taken out of the unprofitable class and eventually made profitable.
W. H. Gardiner, Jr.

Yes. If an old consumer does not use a porch light, chafing dish, curling iron, electric iron,—educate him to the use of these articles, appropriating the expense to the possible increase in revenue. John Craig Hammond.

Advertising matter devoted to educating old customers to increased use of current should undoubtedly be used by every company. The most popular method is the use of "stuffers" accompanying bills and receipts; circular letters in the form of fac-simile typewritten letters will also produce excellent results.
The Philadelphia Elec. Co.

Undoubtedly. The old customer, if you have treated him right, ought to be the easiest one to deal with and to get additional business from. His premises are already wired for current, so that your new proposition does not mean the preliminary expense to him that it does to a non-consumer. He presents a fertile field for increased income and the combined advertising and sales departments ought to be able to sell him a sign or a refrigerating machine, a fan or a flat-iron, with less effort and expense than it takes to land a new customer.
The Brooklyn Edison, M. S. Seelman, Jr.

V 16. In an advertising campaign, what should be the sequence between newspaper advertising, poster display advertising, street-car advertising, circularizing, "follow-up" letters, and the activities of the representatives of the commercial department?

Poster and street-car advertising are at best only general publicity. They are valuable to announce reduction of rates or only special features likely to interest the general public. Circularizing, as generally understood, is a waste of money. "Follow-up" letters should be designed to convince the addressee of his need of electric service, and, further, to make appointment for solicitor. The solicitor should keep such appointments faithfully, turning inquiries into contracts. When the solicitor makes calls upon people who are receiving "follow-up" matter, he should be thoroughly familiar with such matters and should base his talk upon statements made therein. It is impossible to get fair results from "follow-up" advertising without hearty and intelligent co-operation on the part of solicitors.

FRANK B. RAE, JR.

The representative should follow all advertisements, such advertisements being issued in connection with the visit of the representative. For example, the representative should follow up the next day the sending of a letter or circular. Newspaper advertisements should be changed with every issue. There is no dispute over this point—they should be changed with every issue. If street cars are used, once a month for a change is enough. Poster-display advertisements should not be considered by central station men. It will hit once where it will miss ninety-nine times. At certain times of the year, if an extensive campaign has been planned, hit the prospect three times a week. That's enough —not too much under certain conditions.

JOHN CRAIG HAMMOND.

This "sequence" depends to a considerable extent on local conditions, and every company in this respect must be a law unto itself. In advertising which looks for different results, the Brooklyn company uses very little newspaper or poster-display publicity and no street-car cards at all. The monthly bulletin, booklets, circulars and letters comprise the bulk of the advertising. Of course, all inquiries resulting from this advertising (easily identified, as a rule, by means of return post-cards) are turned over to the contract department to follow up.

THE BROOKLYN EDISON, M. S. SEELMAN, JR.

***V 17. What class of advertising is considered most feasible for securing business, in addition to personal solicitation?**

Artistically illuminated signs, a monthly bulletin and advertising on envelopes and bill backs, combined with courteous treatment of consumers, seems most feasible. J. J. CAGNEY.

Personal letters, based upon exact knowledge of addressee's needs and conditions. FRANK B. RAE, JR.

What is good in Denver may not be a success in St. Paul. The local conditions again come to the front. The nature of your consumer counts. A letter properly written—and it must be properly written—will show the best results in the vast majority of cases. Spend ten cents to get out the proper letter rather than three or four cents to get out a circular-effect letter. Newspaper advertising is of great value if properly handled. Execution counts. JOHN CRAIG HAMMOND.

Next to personal solicitation the personal communication is the most effective advertising method. Every such communication should have a reply feature incorporated in it.

THE PHILADELPHIA ELECTRIC CO.

Well-printed and carefully-worded mail matter.

H. A. STRAUSS

A well-organized follow-up system.

E. A. M., N. Y. ED. CO.

Follow-up letters are best. Next best, mailing cards, bulletins, newspaper advertising, street-car advertising, in the order mentioned. W. H. GARDINER, JR.

***V 18. How can the public be induced to regularly read the electric advertising, circular letters and newspaper advertisements?**

Make your story brief, truthful, and to the point, and it will be both interesting and convincing. J. J. CAGNEY.

If the advertising is "home-made," give it up. If the advertising is written up by a level-headed man, the public will need no inducement. Intelligent, well-printed advertising is always read. FRANK B. RAE, JR.

Make it interesting and attractive to them; homely, timely, pertinent; not stereotyped, nor yet necessarily by the use of fantastic designs or vivid colors—these are expensive and, while all right in their way and place, are not always nor even frequently necessary.

Make your advertising appeal to people as something it *pays them* to know of and consider. It is not imperative to be always doing stunts in order to command attention. People are in business to make money, and if you can show them that you can help them to do this, you are sure of an audience. As for residence lighting, most men are naturally disposed to consider of prime importance the appearance, convenience, comfort and sanitation of their homes, and if you appeal to them along these lines, with an occasional and timely specific proposition, in the long run you will not appeal in vain.

Be dignified in your advertising, but don't stand so straight as to be in danger of falling over backward. Verse has its uses, and an electric light jingle now and again is sure to be read eagerly and is not at all out of place.

Base your advertisement on truth, build it up with simple Anglo-Saxon words and sentences, salt it with attractive illustrations, let its appeal be through the fundamental attributes and qualities of human nature, and it will be read all right, even if it is in the form of a plain folder without peculiarities of shape or oddities of color. To achieve this result your advertising must be written by some one with a knowledge of your business and a sympathetic understanding, by some one who has ideas and the ability to express them in picturesque, persuasive and forceful

English. A properly-propelled idea can strike a man between the eyes with all the force of a bullet or a crow-bar.

THE BROOKLYN EDISON, M. S. SEELMAN, JR.

Give them variety, the right kind of variety; tell your story in such an interesting manner and with such well-directed blows that the prospect will be glad to read your letters and circulars. Don't ride an idea or hobby to death—talk sense. Be attractive, but not at the expense of common every-day horse sense.

JOHN CRAIG HAMMOND.

Have all matter of first-rate grade, so that it will first attract the eye, then hold the attention to the end of the statement, which should be as close to the beginning as possible; that is, be brief while instructive. W. H. GARDINER, JR.

By making the same distinctive as well as attractive.

E. A. M., N. Y. ED. CO.

By keeping at it persistently. H. A. STRAUSS.

V 19. What is the best means of getting local newspapers to print articles of general interest on electrical subjects, such as heating apparatus, new type of lamps, etc.?

By the exercise of a little tact newspapers can generally be induced to print any matter that is not "rusty"; but it is doubtless a fact that many of the novelties presented to a newspaper from time to time have already been referred to in its columns.

J. J. CAGNEY.

By carrying an advertisement in the paper and by supplying articles that have a "news" value. Example: the *Saturday Evening Post* in the early spring printed a one-quarter-column article on an electric flat-iron, simply because an actress' name was brought into the story, giving it the "news" value.

FRANK B. RAE, JR.

A personal acquaintance with the editor and frequent heart-to-heart talks with him. F. ELLWOOD SMITH.

Send local editor a sample for his own use.
M. C. TURPIN.

Remember all newspaper men are not fools. Moral: Don't try to fool them all the time. Don't jolly them—be honest with them—tell them you want to earn their good-will by deserving it. Treat the reporter as though he were human. Don't take the exalted position that he is not made of bone and flesh. Educate yourself to the news value of a story; you can't become a newspaper man, maybe, but give the reporter a story when he calls—try, at least. You can trust 999 reporters out of 1000 with your confidence. If you don't want a story made public, tell him so; don't shut up like a clam; explain to him the reason why the story is not ready. Don't keep him waiting any longer than necessary; it will pay you to see and dismiss him as soon as possible. He is a busy fellow—he has other people to see. If he misquotes you, tell him about it—the reporter don't go to the editor—give him a second and third chance. The public will read anything that is interesting. You have a hundred interesting stories around your station and in your business; newspapers will print them for their news value—remember that—*the news value.* Cigars, dinners, drinks, won't win you newspaper favor. If you are not right you won't get it—unless you have the publishers "throttled." Remember, publishers change. JOHN CRAIG HAMMOND.

Have them written up in an interesting style and supply them to the newspaper ready for printing. Do not let them partake of the nature of advertising. The editor will be pleased and the public reads this sort of thing eagerly. H. A. STRAUSS.

Advertise largely with the newspapers or pay the insertions of reading matter. It is very doubtful whether in either of these methods "the game is worth the candle." "X."

Put a good-sized advertisement in their advertising columns. There is usually no difficulty in getting newspapers to print articles upon electrical matters of general interest to the public.
F. D. SAMPSON.

Advertise with them. R. N. KIMBALL.

The good-will of a newspaper of account is always worth having, and the advertising by a central station in such newspaper naturally and properly fosters a friendly feeling. For this reason alone a certain amount of advertising in newspapers would seem advisable and, in the sense above indicated, pays.

All newspaper advertising intelligently done has also a certain very real and cumulative educational value, and if the central station can afford the present outlay for the sake of future business—if it has the money and the patience to sow to-day that it may reap in the years to come—then here is another sense in which newspaper advertising is sure to pay.

Whether newspaper advertising brings a sufficient percentage of direct returns to be immediately profitable is another question and can only be determined by the conditions that govern each local situation. The answer to this question depends almost altogether upon the proportion the possibly remunerative circulation bears to the total circulation for which the central station is called on to pay in its newspaper advertising.

Rates are largely based upon circulation. If a newspaper has a circulation of 50,000 and your advertisement can appear as a feasible proposition to but a possible 1000 or 5000 of this circulation, it is manifestly uneconomical to pay for what might be termed the surplus publicity. It is clearly both cheaper and better to appeal through other channels and methods, directly to the people with whom you may hope to do business on the particular proposition you are advertising.

This is the situation as it obtains in Brooklyn. In New York, Philadelphia, Boston or Baltimore it may be different. In these places a larger percentage of newspaper circulation may be of the "possibly profitable" variety. The matter is therefore one which, in our judgment, calls for special decision in each particular case.

The newspapers should be utilized by all central stations, at least for a "now-and-then" advertisement, on special occasions, such as in the event of a notable addition to the company's property or equipment, on the closing of a big contract, or for the announcement of a reduction in rate or the initiation of some new policy. Also to advertise any unusual, special proposition which is likely to appeal to a wide constituency, or to make a statement to the public in some contingency where the company has been attacked from an official or public quarter, and it seems the part of wisdom to issue a reply.

On such occasions buy space with no niggard hand, use big, well-displayed advertisements and secure for them specially advantageous positions, even if you are obliged to pay more for them. Anything worth doing at all is worth doing thoroughly well.

THE BROOKLYN EDISON, M. S. SEELMAN, JR.

V 20. Does newspaper advertising pay an electric light company?

Advertisements should be carried in the local newspapers of small towns on the score of policy, if for no other reason. If the advertisements are properly gotten up they should bring in some new business. F. ELLWOOD SMITH.

Direct returns are proportional to ability displayed in writing advertisements, indirect returns in influencing public opinion for and against you. In these socialistic times advertising pays, irrespective of direct returns. R. N. KIMBALL.

Yes. At least indirectly. Pleasant business relations and frank dealing with a reputable newspaper are calculated of themselves to constitute an enormously valuable asset.

RALPH R. LAXTON.

I do not think it best so far as obtaining customers, but for a matter of policy I think it is well for a company to have advertising space in local newspapers. F. C. S., MALDEN ELECTRIC CO.

Newspaper advertising usually does not pay except indirectly.

"X."

It depends upon the advertising. Good advertising in the newspaper always pays. FRANK B. RAE, JR.

It should pay if attractively displayed and worded.

F. D. SAMPSON.

An advertisement printed to-day in any form and not followed up will not pay. Newspaper advertising will pay if properly followed up, and the proper copy prepared.
JOHN CRAIG HAMMOND.

Yes, but it is very expensive and better methods are available.
J. J. CAGNEY.

It certainly did not pay us (population of town about 6000).
LUDWIG KEMPER.

V 21. How often should newspaper advertising copy be changed?

As often as you can afford a good, interesting illustration to go with it.
FRANK B. RAE, JR.

Newspaper copy should not appear more than twice.
J. J. CAGNEY.

Every issue.
L. W. EMERICK.

Never use the same copy twice unless you can not improve upon it; then get somebody else to do so.
W. H. GARDINER, JR.

Don't use the same newspaper advertisement twice—change it with every issue.
JOHN CRAIG HAMMOND.

Twice a week.
F. D. SAMPSON.

V 22. Is it better policy to take six-inch single newspaper column daily than a six-inch double column every other day?

There are several reasons why the six-inch double-column every other day should be taken in preference to six-inch single-column every day.
J. J. CAGNEY.

Six-inch double-column every other day.
W. H. GARDINER, JR.

Six-inch double-column every other day is profitable, except in a metropolitan paper. Locality, or "position," as it is called, has considerable to do with this. FRANK B. RAE, JR.

Daily is better. You can tell the story of the Bible in two hundred words. You can tell your story every day in a hundred well-chosen words. JOHN CRAIG HAMMOND.

V 23. Is it better in newspaper advertising to take a page, half-page or quarter-page weekly or semi-weekly than to spend the same amount of money per week in daily advertising?

The constant hammering will bring the better results. If you don't get out good copy at all times, better not advertise at all. Most any kind of advertising will bring some results—good newspaper advertising will bring good results.

JOHN CRAIG HAMMOND.

Believe in constant, regular advertising in a reasonable or even limited amount, rather than occasional or irregular advertising on a large scale. This is especially true if the advertisements have sufficient merit to induce readers to look for them in recognition of that fact. L. W. EMERICK.

The six-inch double-column space will generally do the work. Large advertisements are of value only for advertisers making some startling announcement of special events lasting but a day or two. FRANK B. RAE, JR.

A whole page or half-page will create the most sensation and attention. However, the instantaneous process is not as lasting as a good six-inch double-column advertisement put in daily, especially in the evening paper, which everybody gets time to read. F. D. SAMPSON.

Use up the space every other day rather than every day, weekly or semi-weekly. J. J. CAGNEY.

Do not advertise daily. If you do so, the public loses interest in your advertisements and simply notices the fact that you are advertising. Usually use about six-inch double-column every other day; not over quarter of a page weekly, and on special occasions take a half-page or a page. All advertising matter should be placed in the best position in the paper.

W. H. GARDINER, JR.

We believe in large advertisements. R. N. KIMBALL.

V 24. Does advertising by means of souvenirs pay?

Yes; but much would depend on the design, character and cost of souvenir. J. J. CAGNEY.

In a high-grade business, advertising by souvenirs may pay if the souvenirs are well distributed and of a grade corresponding with grade of the business. W. H. GARDINER, JR.

As a rule, no. Supplemented with a regular campaign, a certain amount may win friends. They don't sell goods.

JOHN CRAIG HAMMOND.

Souvenirs are talked about, but they do not get business.

FRANK B. RAE, JR.

V 25. Does street-car advertising pay an electric light company?

As a general proposition, money spent on street-car and billboard advertising would give greater returns if devoted to personal letter solicitations. A few illuminated billboards are useful in getting other advertisers to equip their boards similarly, and street-car cards, or billboards in a closely-restricted manufacturing district might bring in some business. Generally speaking, however, money spent in this way does not give adequate returns. FRANK B. RAE, JR.

Of all advertising, street-car advertising is of the best. You can not get away from it, it stares you in the face. However, it is sometimes impossible to obtain space in cars in one's own city, on account of the companies controlling the space having it all engaged ahead. F. D. SAMPSON.

Not in our town. ANDREW F. HALL.

Street-car advertising used to supplement other forms of advertising should be effective for the central station. The use of the street-car card as a sole advertising medium would prove of doubtful value. THE PHILADELPHIA ELECTRIC CO.

Broadly speaking, it does not pay an electric light company to place its advertisements in all street cars. It may, however, pay to place advertisements in cars used principally by merchants and wealthier residents. W. H. GARDINER, JR.

Alone, no. It is the least valuable with the possible exception of theatre-programme advertising. It is a "prop" in a long campaign, that is all. Remember you are a central-station man. Publishers of theatre programmes and street-car companies may swamp you with figures and data—figures can be made to lie, after all. JOHN CRAIG HAMMOND.

V 26. Does advertising on paper billboards and painted display boards pay an electric light company?

No; and it is difficult to conceive how an electric light company can expect others to install electric signs if it starts out by endorsing billboard advertising. J. J. CAGNEY.

See answer to V 25. FRANK B. RAE, JR.

The use of billboard advertising and painted display boards should be just as valuable to the electric light company as they are to other advertisers. They would be particularly valuable if illuminated at night, and would help to encourage a similar illumination of boards used by other advertisers.

THE PHILADELPHIA ELECTRIC CO.

If you are trying to get national advertisers and local advertisers to light their billboards and painted signs at night, yes. A painted sign, lighted at night, with a change of copy not less than four times a year, can be made effective. It's not direct—it's publicity, remember. JOHN CRAIG HAMMOND.

Yes, if properly done. W. H. GARDINER, JR.

V 27. Should street display advertising be scattered in paper posters in large quantities along street-car lines or should the same money be spent in permanent painted signs at transfer stations?

Bill posters are an abomination and should not be encouraged by any central-station company. Attractively illuminated signs will convey your message day and night alike.
J. J. CAGNEY.

See answer to V 25. FRANK B. RAE, JR.

Better spend same amount of money in permanent painted signs at transfer stations and have these illuminated. Over one-third of the entire load of street-car system is carried after dark.
W. H. GARDINER, JR.

V 28. With a given appropriation available for poster display advertising, how can the money be spent to the best advantage in a city of 50,000 inhabitants or over?

See answers to V 26 and V 27. J. J. CAGNEY.

See answer to V 25. FRANK B. RAE, JR.

I believe it best to concentrate the expenditure of money in first-rate signs in the centres of traffic and every sign must be the dominant sign of its centre in order to be effective.
W. H. GARDINER, JR.

V 29. Is it best to put a given sum of money into a large number of eight or sixteen-sheet paper posters scattered all over a city, or to put the same amount of money into comparatively few painted signs of a high standard in good localities?

See answers to V 26 and V 27. J. J. CAGNEY.

See answer to V 25. FRANK B. RAE, JR.

Have the painted signs of a high standard in the good localities, but if these do not cover the territory from which business can be obtained, supplement them by eight and sixteen-sheet paper posters, being careful that wherever a paint or paper poster appears it is the dominant display in that locality.

W. H. GARDINER, JR.

V 30. How often should the design and reading matter of large, permanent painted signs be changed?

Every fall and spring. J. J. CAGNEY.

At least once every three months; better once every six weeks. W. H. GARDINER, JR.

V 31. (a) Do pasters on customers' bills or enclosures with same pay? (b) Is it better to have these prepared to meet local conditions or to use those supplied by manufacturers?

If you have a story to tell—and you have—you can get and hold the attention of the consumer by a paster on the bill. If the manufacturer is furnishing you good copy, use it. If not, print them yourself and change every month.

JOHN CRAIG HAMMOND.

(a) Yes; it is an economical method and will give good results.

(b) The pasters or other matter should be adapted to meet local conditions. J. J. CAGNEY.

(a) Yes; provided such pasters or enclosures are attractively gotten up.

(b) Electric manufacturers' dodgers are generally so bad from an advertising standpoint that it is better to prepare such material locally. FRANK B. RAE, JR.

I think they do. Prepare them locally and have them convey as nearly as possible a personal message. RALPH R. LAXTON.

Each solicitor should make a daily report. These reports may be made direct on cards of a catalogue system and scrutinized before filing.

J. J. CAGNEY.

Having a man write out a daily report on special blanks provided for this.

E. A. M., N. Y. ED. Co.

***V 36. Should results obtained by solicitors be computed on number of applications or revenue secured?**

Results obtained should be computed on revenue secured; governed, of course, to a large extent by the amount of business in sight in different districts.

J. J. CAGNEY.

Results should be computed by revenue secured; for doubling the consumption of an existing consumer is better than a new consumer.

R. N. KIMBALL.

In computing results obtained by the solicitor we reckon his value on the amount of new business in number of 16-cp equivalents secured rather than on the number of applications or the revenue received. It would seem unjust to hold him responsible for the financial responsibility of the applicant. If, however, credit and form of contract is approved, and if for any reason for which the company is not responsible service connection is not made, the solicitor should not benefit by having submitted the application to the company.

THE BROOKLYN EDISON, E. W. PHILLIPS.

If the object of the company is to secure new applications, then the results obtained by the solicitors should be computed on this basis. If, however, it happens that the company is after revenue, the solicitors' results should be computed on the basis of revenue.

W. H. GARDINER, JR.

On number of *bona fide* applications. H. A. STRAUSS.

Upon the 16-cp equivalent connected.

E. A. M., N. Y. ED. Co.

***V 37. Is it advisable for a commercial department to offer a premium to the representative turning in the largest estimated revenue for a given period, and to what extent should this be carried?**

No; pay your solicitors a fixed nominal salary and a guaranteed commission on all business written in excess of what you would be entitled to expect if no commission were attached. Avoid promised premiums based indefinitely. J. J. CAGNEY.

I think premiums for the largest estimated revenue may be good in theory, although such a policy would probably arouse dissatisfaction among the solicitors, all those who fail to get premiums attributing the failure to the inferiority of their districts. This may be avoided by giving the districts different ratings. The extent to which this premiumizing should be carried out is hard to say, as it would be entirely governed by local conditions. Obviously it should be to the least extent which will produce the best results. "X."

You are certainly stimulating your representatives by giving the best man a premium. You want the best men and you want to bring the best out in every employee. Sugar goes a long way with every one; sugar your employees in the right way. Encouragement is better than extra fees, if the encouragement is in the shape of advancement to the men who show results.

JOHN CRAIG HAMMOND.

***V 38. Have specialty salesmen such as power or sign experts proven a success?**

Yes. By devoting his attention to one field entirely he becomes expert and thoroughly conversant with this, and can give better and more reliable information in his line than one who makes a specialty of nothing in particular.

E. A. M., N. Y. ED. CO.

Yes; when given sufficient scope. J. J. CAGNEY.

General salesman usually can not be sufficiently expert to get all available business under special conditions. Therefore, if a company is large enough and there is enough special conditions to warrant carrying specialty salesmen, these latter are very desirable and have proven a success. W. H. GARDINER, JR.

***V 39. What is the best method of educating solicitors and representatives?**

The most feasible method of educating such employees would seem to be offered by a series of lectures on business-getting methods, in conjunction with papers and literature on that subject disseminated amongst them. J. J. CAGNEY.

By issuing from time to time instructions and information sheets, which should be kept in a binder for reference.
E. A. M., N. Y. ED. CO.

By holding daily meetings; by having each solicitor read a paper on different phases of the business; by letting each man tell of his experiences and the results secured on the previous day; by taking your solicitors in a body to every branch of the business not less than twice a month. JOHN CRAIG HAMMOND.

V 40. What means have been found advantageous for displacing gas engines and in their stead installing electric power? How about disposing of the gas engines?

***V 41. What inducements should be made in the way of free wiring where electricity is used for power purposes?**

If you get a power contract at a big price or for long terms, then wire free; but if you have to go down very low with your price, free wiring would eat up what little profit there was left.
LUDWIG KEMPER.

It is not necessary to give free wiring. R. N. KIMBALL.

V 42. What is the best method of securing the most extensive use of desk fans?

Judging from the reports made to this company by many central stations selling fan motors, we believe that the best method of securing the most extensive use of desk fans is to enclose suitable advertising to the consumer with monthly bills, this advertising matter usually being furnished by the manufacturer with the name of the central station printed upon it, or, if the central station does not handle fans, with the names of the various contractors who can supply consumer.

This advertising matter should be sent out early in the season, beginning not later than with bills distributed April 1, and being kept up with May, June and July bills. This circular advertising with bills simply calls the attention of current users in a general way and is not likely to produce definite orders at the time the circulars are distributed.

The sale of desk fans depends almost wholly upon weather conditions, and when unusually warm weather is prevalent in a locality newspaper advertisements of suitable size should be printed in all newspapers going to the best classes of residents. It has frequently been found profitable to carry advertising in the street-cars that serve the part of town where the most residents live.

The advertising will do no good whatever unless an ample stock is carried for immediate delivery when the hot weather appears. When the central station does not sell fans direct to the consumer, and the local contractors do not feel warranted in tying up their capital in a stock of fans, some central stations have found it profitable to purchase the fans, carry them in stock, and turn them over to the contractors as their necessities require.

The detail as to whether central stations sell fans or carry stock for the contractor, or whether the contractors both sell and carry the stock, is one that must be decided in each locality according to the local conditions, but our experience has been that if the methods suggested above are followed, and particularly if a satisfactory stock is on hand during the hot term, the sale of fans is doubled or tripled. T. M. MESTON.

Co-operate with manufacturers and set a reasonably low fixed rate for service. J. J. CAGNEY.

***V 43. What is the best method of securing new business in higher class residence districts?**

Advertise carefully in selected newspapers and through special mediums. After this use a first-rate system of follow-up letters, which should be used individually. These should be addressed to the man's business address and should culminate in an appointment to see the superintendent or general manager who, when this is made, can send special representative.

W. H. GARDINER, JR.

The best method of securing business in residence districts is to distribute effective advertising literature and follow up by special representatives provided with fixture illustrations and prices. Such representatives should possess knowledge of wiring costs, and illuminating requirements under varying conditions.

THE BROOKLYN EDISON, E. W. PHILLIPS.

V 44. How can sign business best be developed?

We started with a good sign of our own and then by personal solicitation explained its advantages as an advertising medium. There are now a large number of signs in town as the result of our work. UNITED ELECTRIC LIGHT CO.

In Denver, a campaign was started that changed the name of Denver to "The City of Lights." This was accomplished by advertisements; it was publicity mingled with direct advertising. You have a hundred ways of getting up signs. Don't try to tell the merchant that it is better advertising than newspapers. It is not true, and you don't gain the good-will of the newspaper. Local conditions govern the campaign—a general outline that might be effective for some companies would be a complete failure for others. JOHN CRAIG HAMMOND.

The sign business can best be developed by effective advertising followed up by personal representation. Central stations can increase sign business by furnishing, erecting and wiring free, fixing a reasonable monthly minimum guaranteed consumption.
THE BROOKLYN EDISON, E. W. PHILLIPS.

By systematic follow-up letters and some inducement on the company's part. E. A. M., N. Y. ED. CO.

V 45. Will flat rates assist in developing sign business? If so, how should the signs be controlled?

Yes. Use a time switch for control.
E. A. M., N. Y. ED. CO.

V 46. How can free signs be made profitable if each sign is special?

V 47. In fighting municipal ownership, should publicity methods be used as a counter attack?

Yes; and unless the agitation is met by the fullest publicity, the outcome can not well be otherwise than detrimental to the corporation involved. J. J. CAGNEY.

Yes; municipal ownership rests with the public. Intelligent advertising can always play a very important part in moulding public opinion. Such advertising, however, must be absolutely fair and honest. FRANK B. RAE, JR.

It is always well to take the public into your confidence, and if charges are made against the company publicly, the only reply or countercharges should also be given publicity.
C. A. L., N. Y. ED. CO.

Again, local conditions must govern. If, for example, a newspaper is advocating municipal ownership for political purposes—that is, if the editor is making the campaign to further his own political purposes, it brings one situation to the front. Many newspapers are using municipal ownership as an advertisement; that is, they are trying to win the good-will of the public, to increase their circulation by going before the public as their champions. This appeals to a certain class—it makes more circulation. The majority of the public gloats over the attacks of a newspaper on a public-utility corporation.

As a rule it does not pay to answer untruths—the people forget easily. But if the campaign is a daily affair, then the conditions may change. It is a much better plan to have united effort on the part of the association to fight the question by a campaign of education. This education can be carried on and good results secured. If a local company carries it on it becomes a local question. Newspapers are glad to have you make an answer, you are sitting up and taking notice. Be careful of your remarks, don't take on the spirit of wanting to fight. Don't abuse the reporters on the paper that is fighting you—they are not to blame, the orders come from men higher up. If you don't answer attacks and false reports about municipal ownership, some day the results may prove serious. The attack can be overcome; it can be demonstrated to the thinking public that attacks are wrong. This means a campaign of thought, of careful execution, and the better way is by a combined effort. JOHN CRAIG HAMMOND.

Yes; much of the municipal-ownership sentiment in the large cities is due to a misconception of facts on the part of the public. As a rule, only the one side has been stated, and that with exaggeration and misrepresentation. A large portion of any community is willing to learn the facts and to be guided by them. Conservative people, who have studied the question intelligently and have opportunity to obtain reliable information, know that municipal ownership as an economic question is impracticable and inadvisable from the standpoint of the general welfare of the city taxpayers. The real facts should be made known as publicly and prominently as are the claims of the new municipal-ownership advocates. Where publicity methods of such character have been used the effect has generally been marked and of substantial benefit. THE BROOKLYN EDISON, W. W. FREEMAN.

The real effects of municipal ownership show it to be almost invariably such a dismal failure that the more publicity is given to them, the better, especially if these can be contrasted with results of private ownership and management. The most effective anti-municipal ownership matter should be tactfully circulated when the question of municipal ownership is not up. There need be no fear that such a course will start a municipal-ownership campaign. In most communities there are plenty of cranks, and others having ulterior motives, ready and anxious to start a municipal-ownership campaign whenever the circumstances would warrant. The best assurance against the success of such a campaign is public opinion thoroughly advised of the facts regarding municipal ownership. W. H. GARDINER, JR.

V 48. What percentage of gross receipts should be used for advertising in a city of 10,000 or 12,000 inhabitants?

This depends entirely on how the field has been previously worked. If the business has not been developed, spend as much as you can stand. Every new customer increases the earning value of your property by $100.

BIRMINGHAM RAILWAY, LIGHT AND POWER CO.

Two per cent should bring splendid results.

P. H. KORST.

Two per cent of gross receipts, or charge part of superintendent's time to advertising. H. E. RYDER.

The percentage of gross receipts that should be expended on advertising varies largely. Where a solicitor or solicitors are employed, more money can be afforded for advertising than if the solicitors were not employed, for money spent in advertising will be invested to much better advantage if the resultant enquiries are followed up by solicitors.

I firmly believe in advertising, from my boot-soles up, but I don't have any false views on it. Advertising, considered purely alone—even the very best kind of advertising—direct mail solicitation—will not pay a heavy return on an investment unless it is used directly in connection with and followed up by personal solicitation. So, in this answer, I assume that the question of the percentage of expenditure of the gross receipts on advertising, means when advertising is properly done in connection with solicitation, so as to get the highest efficiency in resultant new business.

The largest volume of returns through advertising secures business that would not otherwise be obtained immediately, and in many cases business that would not come "naturally"—that is, without the exertion of advertising solicitation—until after several years, the net income, meantime, obtained through advertising would in most instances pay for the advertising many times over. Thus, if a customer for a sign is secured through direct mail solicitation and the annual revenue is $60, then, if we assume that the customer would have come on "naturally" at the end of five years, the central station has secured a gross income of $300, and in the meantime the net profit would have paid many times over the cost of the advertising plus the cost of solicitation.

The expenditure of money for an advertising appropriation where the company is prepared to back up the advertising by solicitation, and carefully and conscientiously take care of the customers secured—promptly and efficiently—should be based, not on a percentage of the gross receipts, but contrariwise, should be every cent that the central station can get to put into this vehicle for expanding its business.

Advertising secures new customers. New customers should be considered as an investment and should be paid for and charged to investment account just as surely as though the company had purchased the customers from another company. So far as getting the customer is concerned, where is the difference between buying them from another company or going to the expense of purchasing them through advertising? In either case the customers have to be paid for, and it seems wrong to charge them in one instance to expense account, and in the other instance charge them to the investment account.

Surely, if an electric light company is willing to pay from $50 to $150 each for new customers, even from a competing local company, then it ought to be willing to pay anywhere from $2.00

to $10 each for the same class of customers through advertising in a little town. Just as surely as they would charge the purchase price to the investment account in the first instance, they ought to charge the smaller amount to the investment account in the latter instance.

I believe this statement to be a logical one from a conservative viewpoint, and I believe that, while it is not now generally done, it will be done within a few years, just as is done in other businesses which have advertised for a good many years, where the advertising is done for the purpose of securing customers, which, in a majority of the cases, remain as constant customers year after year.

This latter point should be held strongly in mind as differentiating central-station advertising from a class of advertising where the resultant business is only a desultory sale, in which instance there is not a constant income from the customer, but the profit is all made on one sale.

Let the reader think this over and, before condemning the stand, find any flaw in the argument. It is true that when customers are purchased from another company the apparatus and copper for serving the customers are also purchased. Even then, deducting the cost of the material necessary to serve the customers, it will be found that the price paid for each customer is largely in excess of what it would cost to procure that customer through advertising. Consequently, the inference seems a plain one, that new business obtained through advertising should not be handicapped by charging the cost of obtaining it to expense account when the expense of obtaining a similar customer would be charged to the investment account if the customer were purchased from another company.

Smaller cities of from 10,000 to 12,000 inhabitants can get a more profitable return on money expended on advertising than is the case in the larger cities, because the customer in the smaller towns can have more effect produced on his mind by a small expenditure of money than his busier brother in the large city. It is true that in the smaller town the new money is not always forthcoming to purchase the new customer, either by advertising or outright purchase from another company, and in that event as large a percentage as possible of the gross receipts should be expended on the procurement of new business. No two cases are the same, and no fixed percentage of gross receipts can be set down as a rule to be followed in individual cases where local receipts and conditions may vary widely. There is no manufacturing business in the world in which the percentage of fixed charges and general expenses so rapidly decreases as in the production of electricity. Consequently, every effort should be bent and every cent possible should be expended toward increasing the number of profitable customers. CONVERSE D. MARSH.

V 49. Eliminating the value of advertising in the daily newspapers from a standpoint of "good policy," does the money spent in this manner bring as direct or as remunerative a result as the same amount of money spent in a "follow-up" system of novelty mailing cards, circular letters, etc.?

Newspaper advertising does not bring as direct or as remunerative results as does the same amount of money spent in a good follow-up system of direct mail solicitation, if the latter is not simply thrown together, but is carefully and systematically mapped out by an experienced expert, who has at hand tabulated results on similar work done elsewhere over a period of years. Circular letters, mailing cards, folders, *et cætera*, through the mails, may be absolutely non-productive, or, on the contrary, they may bring very large results.

I have in mind one case where a letter was improved by having six words altered, but the result in replies was increased from three-quarters of one per cent to 9.5 per cent.

Newspaper publicity, if the advertisements are carefully written, is always valuable, but the trouble is that you can not put your finger right down on the results as you can when you have follow-up advertising through a campaign of direct mail solicitation. CONVERSE D. MARSH.

As a general proposition money spent in newspaper advertising for the electric lighting company will not bring as direct or as remunerative results as the same amount of money spent in a follow-up system. THE PHILADELPHIA ELECTRIC CO.

V 50. Is newspaper advertising more resultful when used to supplement "follow-up" advertising or when used as the only method of advertising?

Newspaper advertising is always more profitable when used in connection with follow-up advertising than when used alone. Both the follow-up advertising and the newspaper advertising pay better when they supplement and support each other. The more you "stir things up" intelligently the more people you set to thinking about electricity, and if you have more people thinking on the subject you get more new customers.

CONVERSE D. MARSH.

V 51. Is it good policy for distributing companies to furnish electric signs? If so, under what conditions, as regards construction, erection, maintenance and method of charge—i. e., meter or flat rate?

Yes. We have had fine success by furnishing, installing and taking care of the signs on flat rates.

BIRMINGHAM RAILWAY, LIGHT AND POWER CO.

Yes; construct, erect and maintain free of charge; place either on meter with minimum weekly or monthly charge, or on fixed number of hours burning with time switch to turn off and on; the flat rate being used in this latter connection.

E. A. M., N. Y. ED. CO.

Why not, if the signs are made to pay a good percentage on the investment? The easier and cheaper you make it for a customer to install the electric sign the more customers you will get.

Flat rates, with fixed hours of burning, will bring a larger income for a sign than will meter rates. The result is that if a customer has a fixed amount in his mind in advance of the actual expenditure, and likewise by contract, he will not try to save now and then by turning the sign on too late or turning it off too early. CONVERSE D. MARSH.

W—CONTRACTS AND RATES

W. 1. In event of competition arising, is it better to make long-term contracts, or do business on the basis of orders without any definite term?

In the event of electric or gas competition it is better to make long-term contracts. Your contract customers will ordinarily live up to their contracts, provided you are giving them good service at a fair rate, even though better inducements were offered by your competitor. Without a contract they would probably change over. At any rate, the fear of a change would be a daily menace to you. A. T. LLOYD.

In the case of competition it is a question of whether or not long-term contracts will hold good with the customer. The moral effect would have some benefit, but in competition the best means of meeting a competitor is giving good service, proper attention to customers' wants, and having someone employed who knows your customers personally. Without a knowledge of your people, your competitor will get the better of you, as he starts out with few customers and has time to talk business.

JAMES R. SHURTZ.

I think it better to have a definite contract for a definite period with every customer. The moral effect of this is good, even though it might be tested by law. We aim to renew our contracts for definite periods from time to time, even though competition is not threatened. FRANK W. FRUEAUFF.

A contract should always be made for a definite period, and in the event of severe competition it might possibly be advisable to have contracts covering a period of several years. Our policy is to ask a contract for a minimum of one year; this is never changed except in case of a special wholesale contract, which is made for a period of six years. C. A. L., N. Y. ED. Co.

Make long-term contracts. J. J. CAGNEY.

Long-term contracts are the greatest discouragement to competing companies. By all means do all business on as long-term contracts as possible to secure. GEO. N. TIDD.

Customers would probably be inclined to appreciate most the company least arbitrary in its business matters.

RALPH R. LAXTON.

With competition in the field it is necessary to get all the business possible and, in order to do so, the fewer restrictions the better. P. S. YOUNG.

If special individual rates are made, they had better be, under all circumstances, only for short-term contracts, but if competition is conducted under a standard form of contract having a wide range of differential and good business-getting qualities, the objections to long-term contracts are minimized.

W. H. GARDINER, JR.

W 2. Is not a very short form of contract for electric service to general customers just as satisfactory as one with all possible conditions mentioned?

We require no signed contract from customer. We hand him printed rules and regulations, instructions for reading his meter, instructions for testing his meter roughly on his premises, the cost of each light per hour at our rates and our discounts. In case of a meter deposit we give a certificate of deposit.

FRANK BECKWITH.

This is largely dependent on local jurisprudence; in our standard contracts we have endeavored to anticipate all possible misunderstanding or confusion likely to arise between the supply company and the consumer, and our ability to point to a clause covering the question raised has, in ninety per cent of cases, had a deterring effect upon the consumers disposed to create trouble.

J. J. CAGNEY.

A short form of contract seems to be all that is necessary, but think it well to have reference to the rules and regulations of the company embodied in the contract. This will serve the purpose and does not tend to confuse the consumer.

FRANK W. FRUEAUFF.

A uniform contract is always best. Several contract forms may lead to confusion where a party may be a customer in various parts of the city, as, for instance, in his residence and his place of business. It would not seem advisable to use a cumbersome form of contract, but the general conditions should be stated as clearly and precisely as possible to give the company thorough protection in the case of legal complication.

C. A. L., N. Y. ED. CO.

Yes, provided it covers the essential points.

RALPH R. LAXTON.

A short and concise form should always be adopted.

JAMES R. SHURTZ.

A short form of contract is best, provided it is sufficiently flexible in form to cover the normal ranges of conditions without its legality and clearness being sacrificed to brevity.

W. H. GARDINER, JR.

W 3. Is it advisable to make it a practice not to make a nominal minimum monthly guarantee on contracts for electric service?

I think every consumer should guarantee a monthly minimum, for without it a good portion of the costs occasioned by that consumer must be met by other consumers, which is unfair. We have had no trouble in collecting the minimum charge.

FRANK W. FRUEAUFF.

We make no minimum charges except in cases of wholesale contracts where a party guarantees a certain consumption in order to entitle him to this wholesale rate. Since abolishing the minimum charge under our ordinary retail lighting form and also on our power schedule, the results have been more than satisfactory. C. A. L., N. Y. ED. Co.

All electrical contracts should carry a minimum monthly guarantee of some amount. GEO. N. TIDD.
F. ELLWOOD SMITH.
B. J. DENMAN.
P. S. YOUNG.

Experience has taught us that a minimum charge of $1.00 for each connection is advisable. FRANK BECKWITH.

Where the company has suffered little or no extra expense, yes; where it has made considerable expenditure to reach the consumers' premises, no. J. J. CAGNEY.

It is not advisable to sell current without a stated minimum. The word "minimum" is not the best word to use in taking on a new customer, and by having a differential rate no trouble should be experienced in establishing minimum charges.
JAMES R. SHURTZ.

Omitting nominal monthly guarantees may secure a number of additional customers, but, generally speaking, customers who will not agree to this guarantee are not profitable.
W. H. GARDINER, JR.

Minimum bills are causing much ill feeling. If a customer pays for all installation, the "minimum bill" idea can be taken care of in rates in general; and this proves fair, as at some stage of the game every customer is a minimum user.
S. B. CUSHING.

***W 4. What are the best dozen papers on the rate question that have appeared in the electric journals or association proceedings?**

Below is a list of interesting articles on the rate question and on cost, arranged in chronological order. Mr. Wright's paper of 1901 is by far the most comprehensive and exhaustive on the subject.

Cost of Electricity Supply, Arthur Wright, 1896. Municipal Electrical Association, England.

Charging for Electric Current on the Wright Demand System, R. S. Hale, 1896. *Electrical Engineer,* October 21.

Profitable Extensions of Electricity Supply Stations, Arthur Wright, 1897. National Electric Light Association.

Public Lighting in Relation to Public Ownership and Operation, Alex. Dow, 1896. National Electric Light Association.

Equitable Uniform and Competitive Rates, Henry L. Doherty, 1900. National Electric Light Association.

Some Principles Underlying the Profitable Sale of Electricity, Arthur Wright, 1901. Institution of Electrical Engineers.

The Four C System, L. R. Wallis, 1901. National Electric Light Association.

Rates, Henry L. Doherty, 1901, Northwestern Electrical Association.

Presidential Address of Henry L. Doherty, 1902, National Electric Light Association.

Results Obtained from the Use of the Wright Demand System of Charging, John W. Ferguson, 1904. Association of Edison Illuminating Companies.

The Boston Rate System, A. S. Knight, 1904. Association of Edison Illuminating Companies.

Graded Costs of Electric Supply, Mathias E. Turner, 1904. Ohio Electric Light Association.

Preliminary Draft for Report of Committee on Rates and Costs. National Electric Light Association, 1905.

Report of the Committee on Cost Determination, 1905. Ohio Electric Light Association.

Maximum Demand, J. S. Codman, 1905. *Electrical World and Engineer,* September 23.

J. S. Codman.

W 5. What system of rates is being adopted by central stations for selling current for lighting purposes?

The system of rates that is increasingly being adopted for selling current for lighting purposes is the demand system. Fundamentally, this system consists in basing the charge to the customer on his maximum demand and also on his consumption. Prior to 1897 there were probably no companies in this country using a demand system of charging. To-day the writer has a list of sixty-seven companies that have adopted the demand system in some form or other, and this list is undoubtedly very incomplete. J. S. CODMAN.

A demand system, or its equivalent, is being introduced by central stations for the sale of current for lighting purposes.
B. J. DENMAN.

Our retail lighting rate is ten cents a kilowatt-hour, irrespective of the average use, the connected load or the demand; in other words, a flat rate. Our power schedule begins at ten cents a kilowatt-hour and decreases as the consumption increases, reaching for large consumption a minimum of four cents. The amount used at four cents, however, is the excess over the quantity used on the previously stated high amount. Under our wholesale schedule the price begins under two contracts at ten cents per kilowatt-hour and decreases as the average burning increases. Under the special wholesale contract the maximum price is five cents, and decreases in gradual amounts in proportion to the increased consumption. C. A. L., N. Y. ED. CO.

It seems to me that at present there are two divergent paths being followed. Perhaps the predominating one is an extension of the Doherty rate and the Wright demand rate under standard contracts made indiscriminately applicable to all customers and classes of customers. Simultaneously with the extension of these more intricate rates, the uniform rate by meter has many advocates. All of these systems seem to be coming, in fact, as successors to the rather chaotic condition where special rates were made with individual customers. W. H. GARDINER, JR.

W 6. Will the demand system of rating prove practical for plants in cities of 15,000 to 25,000 population?

A demand system of charging has already proven to be practical in small cities as well as in large, as evidenced by the number of small towns that have adopted one. Below is given a list of twenty-three cities or towns, with a population of less than 25,000 each, which are believed to have adopted a demand system. There are probably many others.

	Population
Chester, Mass	1,450
Bangor, Me	21,850
Portsmouth, N. H	10,837
Bennington, Vt	5,656
Middlebury, Vt	1,897
Rutland, Vt	11,499
Nyack, N. Y	4,275
Saranac Lake, N. Y	2,594
Rome, N. Y	15,343
Columbus, Ga	17,614
Greenville, O	5,501
Belvidere, Ill	6,937
Decorah, Ia	3,246
Iowa City, Ia	7,987
Jefferson, Ia	2,601
Waukon, Ia	2,153
Mason City, Ia	6,746
Houghton, Mich	3,359
Beloit, Wis	10,436
Corsicana, Tex	9,313
El Paso, Tex	15,906
Waco, Tex	20,686
Colorado Springs, Col	21,085

J. S. Codman.

We find the demand system very satisfactory for stores, hotels, restaurants, liveries, and so forth. Vary the rate of different customers from thirty to fifty hours per month according to conditions. Have a population of 4000. P. A. Gould.

The demand system should prove practicable for plants in cities of from 15,000 to 25,000 population. B. J. Denman.

Yes, if it is applied in a simple form. Some demand systems seem to me to be getting altogether too intricate.

W. H. Gardiner, Jr.

W 7. Are flat rates a disadvantage under all circumstances?

Flat rates are a disadvantage unless the customers' load factor is taken into consideration when deciding on the rate.

The rate should be based on the maximum demand, and periodical tests be made to see that the load factor has not decreased.

B. J. DENMAN.

I think the principle of a flat rate is wrong, but under special conditions, where the company controls the demand and consumption over a given period, a flat rate will attract much desirable business; I refer particularly to display lighting where the company turns on and off the consumer's lights.

FRANK W. FRUEAUFF.

No; flat commercial rates will help to "float" the revenue for the smaller plants, and will help get some business that you otherwise could not get; and, too, in the smaller retail stores lamps are not wired in that are not to be used approximately the same number of hours each year. L. W. GREENE.

For small installations of about 250 watts we give flat rates, but over that we consider meter rates the only way to charge. There are, of course, special cases, where you can control the current by time switches, where flat rates will work all right.

LUDWIG KEMPER.

No. If you know all the conditions under which a customer or class of customers takes current, you can safely make a flat rate, but this is not often the case. J. S. CODMAN.

We make flat rate for all-night service only.

FRANK BECKWITH.

No; particularly in the case of sign or decorative lighting.

J. J. CAGNEY.
E. A. M., N. Y. ED. CO.

Under almost all circumstances. H. A. STRAUSS.

No. Flat rates, if high enough, are very satisfactory and will bring to the central station business it can not secure by other means, and also increase the revenue per lamp connected. The old trouble with flat rates was that they were too low.

GEO. N. TIDD.

A flat rate with, say, ten quantitative discount limits is one that will do away with minimum bills and maximum meters and cause less municipal inspection and regulation.

S. B. CUSHING.

Special individual flat rates may be discriminative and indefensible. Uniform flat rates are not good business-getters and are individually very inequitable; on the other hand, the public likes them, but on account of their not being good business-getters, they tend to the maintenance of high costs and prices.

W. H. GARDINER, JR.

Yes, for even if you have a customer that you can put on a flat rate, knowing definitely the conditions of the service required, there is the disadvantage of creating a demand for flat rates among customers not entitled to such, and it is difficult to explain to them that they are not being discriminated against.

F. C. S., MALDEN ELECTRIC CO.

W 8. Is it necessary to use lock switches on electric signs, on flat rates, turned on and off by company's patrolmen?

Not necessary, but perhaps desirable.

E. A. M., N. Y. ED. CO.

W 9. Is it possible to develop a rate system that will charge every customer prices proportional to the costs individually and collectively incurred, within an error of ten per cent?

It is doubtful if it is possible to develop a rate system that will make the price to every customer bear a fixed proportion to the cost of supplying him, within an error of not more than ten per cent. It certainly has not yet been done, although a demand system of charging devised with the above end in view might have an error of not more than twenty-five or thirty per cent, and would certainly have less error than any other system yet proposed. J. S. CODMAN.

I think it possible to develop a rate system that would charge each consumer his costs within an error of ten per cent, but such a system could not be universally applied. With laws and practice as at present, the companies will always retain some undesirable and unprofitable business. We can therefore only hope, in attempting to make equitable rates, to make them reasonably but not absolutely so. FRANK W. FRUEAUFF.

No, because the costs individually incurred—that is, the costs that would be saved were the individual service not rendered—may be in the aggregate less than 50 per cent of the total costs. The balance of the costs, which may be described as general "readiness-to-serve" costs or "joint costs" may amount to over 50 per cent of the total costs and bear no specific relation to the individual conditions of taking. As they have no direct connection or relation with the individual customer, it would be hard to conceive of a rate system that would apportion these "joint costs" in any cost relation with individual charges.

W. H. GARDINER, JR.

Yes; but it will be cumbersome. H. A. STRAUSS.

Yes; but such a rate might result in loss of business.

P. S. YOUNG.

W 10. Assuming that all charges for electrical service can be made in direct proportion to costs individually and collectively incurred, is it wise and best for the community so to charge if by so doing output is restricted and the average price is held above what could be attained if individual charges were so adjusted as to least restrict use or consumption, and yet in the aggregate properly balance the books?

Probably not. Still, it is conceivable that it might be wise for a community to adopt such a policy, even if the average price were as a result somewhat higher than it might otherwise be. It is, however, almost certainly bad for a community to adopt a system of charges greatly out of proportion to costs, as, for instance, a flat-rate system. J. S. CODMAN.

I do not see how apportioning charges where they directly belong will restrict output. Our experience has been that it has materially increased it. If, ideally, such a condition should be brought about, much undesirable business would be made to pay, and this would in no way retard the desirable business, but would act as a stimulus, as the company would be able to make every concession to attract new business. Under this plan the average rate could be very much lower than anything now in effect. FRANK W. FRUEAUFF.

The assumption is incorrect; but granting it, it may be wise to have rates meet costs in this manner. It is evidently not best for the community to do so, because the primary interest of the community is in the maximum service of standard quality at the minimum total price. To best accomplish the end implied in the question, individually apportionable costs should be met wherever incurred. Joint costs should be met in such manner as least to restrict trade; that is, most where the service is most valuable.
W. H. GARDINER, JR.

The condition cited would be temporary only; in the long run the scientifically laid out system would win out—barring the factor of competition. H. A. STRAUSS.

No. JAMES R. SHURTZ.

W 11. (a) What are the objections to a two-rate schedule by which a charge is made for a certain number of hours' use per day or per month of a customer's equipment, and a lower charge for the excess? How may they be overcome? Should such a schedule be different for power service from that adopted for lighting service? (b) It being understood that the higher charge is occasioned by the "fixed charges" of your plant, how may these fixed charges be determined per kilowatt-hour, and how may the

number of hours per day to be charged at the high rate be determined? (c) Should not the lower charge be based strictly on the operating charges per kilowatt-hour sold? And would the lower charge be decreased for very high average daily use?

(a) The objection is the bad effect of basing the charge on the customer's equipment. The remedy is to base the charge on the customer's actual maximum demand.

The objections to the equipment as basis of charge are as follows:

1st. It discourages the installation of lamps and therefore the use of electricity.

2d. It is necessary to require the customer not to change his equipment without notifying the company. Such a requirment seriously impairs the value of electric service.

3d. A customer, either wilfully or through ignorance, will often make changes in his equipment without notifying the company; this necessitates frequent inspections of his premises, which are an annoyance to him and a great expense to the company if made often enough to be of any use.

4th. The basis of charge is unjust. It costs the company no more to supply a customer who has fifty lamps but who never uses more than twenty-five simultaneously, than it does to supply a customer having twenty-five lamps but who uses all at once.

All the above objections are overcome if the actual maximum demand of the customer is made the basis of charge instead of the equipment. The actual maximum demand can be measured by a demand indicator or controlled by a "current or demand limiter," both of which instruments are cheap. (See answer to W 19.)

(b) First, the annual fixed charges should be divided by the sum of the maximum demands of the customers, measured in kilowatts. The results will be the proper charge to the customer per year per kilowatt of his maximum demand. Dividing this by 365 we have the charge per day per kilowatt of maximum demand. If the charge per kilowatt per day, for example, figures out to be ten cents, and if the higher rate is to be charged for one hour per day, then ten cents per kilowatt-hour represents the portion of the higher rate that will cover the fixed charges.

The full value of the higher rate will be obtained by adding the lower rate to ten cents; that is, if the lower rate is five cents the full rate will be fifteen cents.

(c) The lower charge should not be strictly based on the operating or running expenses. If it were, in most cases the lower rate would not be greater than two cents. It must be remembered that some of the expenses of a station are proportional neither to maximum demand nor to output. Nevertheless, these "floating" expenses must be covered in some way or other and it is usually best to accomplish this by adding something to the lower rate per kilowatt-hour. For very high average daily use or for very high total consumption, it might be well to reduce the lower rate. J. S. CODMAN.

(a) Objections.

1. Individual equipment is oftentimes a matter of dispute.
2. The rate is difficult for customers to understand.
3. Such a rate does not follow the cost.

The first two objections can be overcome by education; the last can not be overcome without changing the system.

P. S. YOUNG.

(a) The two-rate schedule should not be based on the customer's equipment or connected load, as it is seldom that the entire connected load may be in operation at any one time; the rates should be based on his maximum demand. (b) Fixed charges may be determined, if the investment in all accounts is known, by charging a certain per cent per annum of this sufficient to cover interest, depreciation, taxes and insurance; by dividing the amount thus obtained by the capacity, the fixed charge per kilowatt-hour to cover the fixed charges would be one-thirtieth of the fixed charges that he incurs per month.

If a customer guarantees thirty hours' use of the maximum demand, for any current used in excess of this he should be charged a smaller amount per kilowatt-hour, which is sufficient to cover operating expenses; the first thirty hours' use of the maximum demand should be the minimum bill. In residence lighting, where thirty hours' use of the maximum demand is not guaranteed, the customer should be required to pay for the first sixty hours' use per month of his demand at the higher rate, and the excess should be at the lower rate. This is necessary on account of the small use during the summer months, which will not average thirty hours' use of the maximum. (c) A lower rate should be based strictly on the operating charges per kilowatt-hour unless the total expense is divided into standing and running expenses; standing expenses to include fixed charges and such operating expenses as are constant regardless of output. In this case the lower charge would be based on operating expenses that vary with the output, such as fuel. B. J. DENMAN.

(a) The objections are overcome by a short explanation, in which the consumer is informed that the reduction is made in the rate after a certain number of hours are guaranteed each month. Rates for power should differ from lighting rates, particularly so if power is consumed in the daytime. (b) The capacity and the cost of the equipment in station should determine the rate. After the rate has been established, the minimum should be figured on the following basis: For each additional kilowatt at a certain cost, a certain consumption of kilowatt-hours should be guaranteed at a certain rate. (c) In some cases the lower charge could be based on the operating cost. This would not hold good in all cases, as the consumption might reach a point whereby other charges would enter in addition to operating.

JAMES R. SHURTZ.

W 12. (a) What should be considered in fixing the amount of the maximum monthly charge per customer—anything besides interest on meter and connections, cost of reading and maintaining meter, and core loss if alternating current is used? (b) Is a minimum charge just and fair if it is any greater than the amount of these items? (c) If a minimum charge is made to customers supplied from separate transformers, is it made to those supplied from a 'bus line?

(a) The maximum monthly charge would be determined on the amount of 16-cp lamps connected that would ordinarily be used. The structure value of the station should enter these costs in addition to the meter connections and other costs of operating.

(b) In some cases the minimum charge is justifiable when it is beyond these charges, as some classes of service require particular and immediate attention. (c) The minimum charge should be made on service supplied from 'bus-line, as it is well to avoid even the appearance of discrimination.

JAMES R. SHURTZ.

W 13. What objection, if any, is there to a system of rates somewhat as follows and what are its advantages: For general service, ten cents a kilowatt-hour. For a guaranteed average use of four hours daily per lamp, eight cents a kilowatt-hour; ditto five hours, seven cents; ditto six hours, six cents; ditto eight hours, five cents; with the guaranteed amount of kilowatt-hours monthly specified in the contract, as based on the particular installation? Power and light to be reckoned on the same basis of 16-cp equivalents. The customer to make a contract on one or the other of these bases.

The system of rates as given might encourage long-hour users, but it would seem that this system is not as advantageous as the demand system, as the average cost would probably be less with the demand system. The rates should not be based on the number of hours' use per lamp, as suggested, as this would discourage proper installations, hence the service would not be as satisfactory. If the rate is based on the number of lamps, the customer will probably not install as many as he actually requires. If the rates take into account the number of hours' average daily use of the demand, there should be no difference in the rates for lighting and power, the cost of lamp renewals being excluded.

B. J. DENMAN.

This plan might premiumize most undesirable business, being on a monthly basis. For example, a consumer might use a large quantity in the month of December and secure a very low rate, and the remainder of the year his demand would lie idle and the company would receive little of it. FRANK W. FRUEAUFF.

Our maximum retail lighting rate is 12 cents per kilowatt-hour. For an installation of not less than 20 16-cp equivalent and a guaranteed daily average use of three and one-half hours of the total 16-cp equivalent connected, 10 cents per kilowatt-hour.

For a minimum monthly guarantee for eight months of the year of 1250 kilowatt-hours based on the kilowatt capacity of the total connected equipment, such total installation to be used not less than one hour per day, 16 cents per kilowatt-hour for the first two hours average daily use, 7.5 cents for the third and fourth hours, and 5 cents for the excess of four hours.

One horse-power is rated as equivalent to 15 16-cp incandescent lamps of 50-watt capacity each, and motors of small size are operated under this schedule.

Our maximum rate for power usage is 10 cents per kilowatt-hour, subject to a schedule of discounts reckoned on the monthly consumption, the lowest net rate under such printed schedule being 5 cents per kilowatt-hour.

THE BROOKLYN EDISON, E. W. PHILLIPS.

No objection, provided you can secure it. Schedule is plenty high enough. You can not secure much large long-hour power business on the basis named. GEO. N. TIDD.

W 14. Under what circumstances is a rate of (a) ten cents per kilowatt-hour, including free lamps and renewals, justified for commercial service? (b) Five cents? (c) Three cents?

(a) Generally. (b) Very rarely, and only to very large consumers. (c) Practically never. H. A. STRAUSS.

W 15. What would be a fair price for lamps per year under the following conditions: Two hundred 16-cp lamps on moonlight midnight schedule, coal $4.50 per ton. Lamps in multiple through transformers supplying twelve lamps each?

W 16. If you furnish Nernst lamps and renewals free, what is your average price per kilowatt-hour sold to customers using the lamps, and what is your base or gross price?

W 17. What method do you adopt in connection with contracts made on a long-hour rate schedule to protect the supply company from too low rates, caused by customers installing more lights?

If the charge to the customer, instead of being based on his equipment, is based on the reading of a demand indicator, the company will be protected even if the customer does install more lights. Also, if the reading of the indicator is higher than the supposed connected load, it will at once be evident that the customer has installed more lights. Indicators for measuring maximum demand can now be purchased very cheaply, about $6.00 up to twenty-five amperes capacity. J. S. CODMAN.

We base our prices on the maximum demand as measured by a Wright indicator and if a customer installs more lights and uses them, they show up on the Wright indicator. In the case of customers where we do not install Wright indicators, we make a recount at regular intervals. The only cases in which we do not install indicators is where a customer has a very small number of lamps, in which case we recount every year or every eighteen months unless the bill should show an abnormal increase, in which case, we should recount immediately. In the case of three-phase power, likewise, we haven't any satisfactory indicator, and we make a test on these places once a year.

R. S. HALE.

In most cases we install Wright meters. In some cases, where the load is easily checked, we do not install Wright meters, but check twice a year. In residence lighting where an assessed demand is used we recheck whenever the rate gets below a certain minimum. J. B. LUKES.

We make it a practice to check at least once or twice a year the number of lamps installed on all consumers paying on a demand basis. FRANK W. FRUEAUFF.

We install Wright discount meters in nearly every case where special rate is given for long-hour service and base the charges each month on the maximum demand. P. A. Gould.

Install the Wright discount indicator. F. Ellwood Smith.

Regular semi-yearly inspection should be made.
P. S. Young.

W 18. (a) Under what circumstances do you consider it wise to quote lower rates than are specified in your regular printed form of contract? (b) Is a reduced rate to large or "wholesale" customers, in the shape of a special printed or fixed schedule, justifiable? (c) If so, how may the wholesale rate be properly determined, and what should be the conditions under which it would be applied?

If possible avoid it altogether by adopting a form of contract that will automatically give a low rate to the customer who is entitled to it. (b) The best system of rates is a demand system with additional wholesale discounts for quantity. The wholesale discounts should be on the "block" system; that is, they should be given on the excess of the bill over a certain figure, not on the whole bill. J. S. Codman.

Rates should be applicable to anyone. There should be no "specials." R. N. Kimball.

(a) In case of large, even loads on contracts, special rates should be made. (b) Yes. (c) By determining the demand on the station. James R. Shurtz.

(a) Never quote rates lower than the regular printed form of contract, which should contain a differential system of sufficient range. If it doesn't, the system should be changed.

(b) This depends entirely on the general rate system used by the company. If it is a uniform rate, special wholesale rates might be justified. If a differential system is used, it should include the wholesale business. W. H. Gardiner, Jr.

W 19. As most power customers use services at the time of peak load, and hence share in the fixed charges, why is it fair to charge any other rate schedule for power than for lighting, the cost of lamps and renewals being excluded, and it being understood that your rate schedule takes account of the number of hours average daily use?

Power customers, as a class, are entitled to a somewhat lower rate than lighting customers, even if rate schedule takes account of the number of hours average daily use, because the diversity in the time of maximum demand among power customers is much greater than among lighting customers. J. S. CODMAN.

If rates for power and lighting customers were fixed on the same basis, taking into account the number of hours of average daily use, it would probably result in prohibitive power rates. It seems better to modify theoretically correct rates to meet business conditions. It is good business, and seems fair, to give power customers a special rate, for the reason that they are consumers of large quantities of current for nine or ten hours a day every business day in the year, while lighting customers are consumers for only a few hours each evening. The reasons given above seem sufficient for giving a special rate to power consumers, in spite of the fact that they use service at the time of peak load. As a rule, however, they cross the peak load for only six weeks or two months of the year, which fact should tend to limit the number of power customers rather than to affect the rates charged those who are accepted. For example, as a general rule, it seems wise to place such a limit on the power load accepted that the power load plus the lighting load in winter shall not exceed the total overload capacity of the station, not including such reserve apparatus as local conditions make necessary.

ALEX. J. CAMPBELL.

It is not a question of fairness, but rather to discourage the demand for power at a time when it is urgently required for lighting purposes. J. J. CAGNEY.

Power consumers in most cases consume at peak load, but they also return revenue at the time when the load does not reach anywhere near the peak; and taking current at times when the cost is comparatively small signifies a lower rate, as their consumption at the peak load is a small percentage of their total consumption. JAMES R. SHURTZ.

Because the power business won't stand lighting rates.
W. H. GARDINER, JR.

Power customers help to improve the all-day efficiency of the plant, since they do not add proportionately to fixed charges, maintenance, attendance, and so forth. For this reason they can be taken profitably at a lower rate. There seems to be no good reason why a customer using power should have a lower rate than the consumer of an equal amount of current used for lighting during the same hours. RALPH R. LAXTON.

W 20. Do you sell current for fans at flat rates during the summer months, or at meter rates? Do you make special fan contracts, or otherwise encourage fan business, and with what success?

We make a flat rate of $3.00 per month for fan service, encouraging this business as far as possible, as this load never comes on at time of our maximum yearly demand.
FRANK W. FRUEAUFF.

Yes; flat rate $2.00 per month per fan. Yes; advertise, talk about hot weather and so forth. A fan load pays.
W. W. FULLER.

Current for fans is sold during the summer months at both flat and meter rates. We have encouraged the flat-rate fan business in the summer with considerable success, and believe it policy to make a fairly low rate on this business.
T. H. T. & L. Co.

We sell current for fans during the summer months on a meter basis. We make special fan contracts, that is, rent fans for $1.00 per month during the summer season; this rental to go toward the payment for the fan if the customer wishes to purchase same at the end of the season. Fans are sold at cost. Fans that we have rented for two years and obtained $6.00 rental on, we dispose of the third year for $5.00 to those of our customers who care to buy. In this way we have been able to establish a large summer fan business. F. C. S., MALDEN ELECTRIC CO.

We sell fan current on either flat or meter rates. The people are just beginning to realize that fans are cool in summer, and useful in winter for keeping show windows clear of frost and circulating the heat through rooms.

LUDWIG KEMPER.

On meter rates to customers using lights and on high flat rate (sufficient to make business attractive), to customers not using any other form of electricity. G. P. BULLIS.

On meter rates. No special inducement is offered other than calling attention to the comforts to be derived from the use of fans during the heated term. E. A. M., N. Y. ED. CO.

Allow consumers regular incandescent meter rate, but caution them to notify you of connection so that transformer capacity may not be exceeded, and co-operate with fan manufacturers.

J. J. CAGNEY.

Meter rates. Sometimes fans are rented, say at $3.00 for three months' use and pro rata for each additional month.

F. ELLWOOD SMITH.

Yes. Sell all current for fans on flat rates. You will derive a large revenue from your fan business and also encourage the increase of fan business. GEO. N. TIDD.

W 21. Have you had special success with any plan of encouraging off-peak business, such as making special contracts to shut down steam and electric plants during summer months? What is your policy in such cases?

It is not necessary to make any reduction in the rate for off-peak business, nor for plants that contract to shut down during the summer months. Such customers do not *have as high demand* as regular customers and if the rates are based on maximum demand their fixed charge will be reduced so that their average rate will be very low. B. J. DENMAN.

Have a number of customers that buy power during summer months only. Our flat-rate sign customers whose signs do not go on until six p. m., get a special all-the-year-round discount. Two-thirds of our contracts are made in this way.
P. H. KORST.

Have experienced very great success with off-peak business during the entire year by taking motor load subject to overlapping peak in winter months. GEO. N. TIDD.

W 22. What is the best term to use in defining candle-power or size of lamps to be furnished under municipal contracts?

Something along the following lines is suggested for arc lamps:

The arc lamps shall be of the —— type, and shall have a capacity of —— amperes with a difference of potential of —— volts between the terminals, and shall require for their proper operation not less than —— watts of electrical energy on the average, and not less than —— watts in any case; said electrical energy to be measured between the terminals of the lamp.

The makers will supply the necessary information so that the blanks can be properly filled in. If alternating-current lamps are used the true watts should be given; the minimum energy allowed should be perhaps five per cent less than the average.

For series incandescent lamps the following is suggested:

Incandescent lamps shall be of the type known commercially as —— cp, —— amperes, series incandescent lamps.

Perhaps it would also be well to say that the lamps under contract shall be substantially the same as lamps in use at the time or same as a certain style and type of lamp that has been shown or submitted. ALEX. J. CAMPBELL.

Rating should be given in watts consumed at terminals. If necessary to state candle-power, state it "so-called" 1200-cp or 2000-cp, as the case may be.

F. C. S., MALDEN ELECTRIC CO.
F. ELLWOOD SMITH.

NOTE—In view of the radical changes in both arc and incandescent lighting that might reasonably be expected to become commercially practicable in the near future, it might be a good precaution to insert behind specification of lamps the words "or their equivalent in illuminating power." EDITOR.

For instance: Each lamp will be operated at —— amperes and —— volts, consuming —— true watts and having a rating of —— candle-power. H. A. STRAUSS.

It is best to designate lamps by wattage, as it is the energy of the lamps that concerns the electric company, and as the candle-power efficiency of lamps varies considerably.

S. B. CUSHING.

W 23. On what terms should service be supplied to employees in their actual homes?

This company discounts 50 per cent from regular rates.

UNITED ELEC. LT. CO.
HERBERT MCNULTA.

We believe in giving service to employees at approximate cost of manufacture. BIRMINGHAM RY., LT. AND POWER CO.

Think employees should have power rates so as to make it an inducement for them to use flat-irons and heating devices of all kind and tell people about them, which is advertising for the company. H. E. RYDER.

At cost. A. PETERS.

W 24. What is the lowest rate for power charged by members to consumers of average of 2000 to 3000 kilowatt-hours per month?

Seven cents less 14 per cent, less discounts up to 40 per cent for consumption of over 100 kilowatts per horse-power per month, less 10 per cent additional if not used during peak, less 5 per cent on five-year contract or 15 per cent on ten-year contract. BIRMINGHAM RY., LT. AND POWER CO.

Two cents per kilowatt-hour. F. D. SAMPSON.

One and one-half cents per kilowatt-hour.
H. D. LARRABEE.

Three cents. A. PETERS.

Three cents per kilowatt-hour less 5 per cent cash discount.
P. H. KORST.

W 25. On series arc systems, contract, all expenses and risk considered, why is the rate per kilowatt-hour so much lower than the same service, metered, on the multiple system?

We do not consider the risks much greater for our arc system—two series of thirty-one arcs each—than for our 2300-volt lines necessary for the multiple arcs. Our multiple arcs are burned nearly all during the peak only. Our series arcs burn about eleven hours and hence only one-fifth or one-fourth of the power they consume is taken when power is most valuable—that is during the peak. Hence, we feel justified in charging at a lower rate per kilowatt-hour for the series arc service.
W. H. THOMSON, JR.

Because hours of burning are fixed and income known in advance, whereas with metered service neither are known and the hours of burning may be less. The meter rate should in equity be sliding, so that for the long-hour service the income would be the same in both cases. HERBERT MCNULTA.

The average hours of burning are so much greater, the load is constant, and at a time when a load is most desirable and should be most encouraged; besides, as a rule, there is absolutely no risk to be taken about prompt payment where the service is sold to municipalities. F. D. SAMPSON.

All flat-rate lighting is at a lower rate per kilowatt-hour than a metered service, this class of consumer usually being a long-hour user. A. PETERS.

A very few years ago, the series arc system at 1000, or so, volts with a uniform load was materially cheaper, considering territory to be covered, than any multiple incandescent system then known. To-day, with improved apparatus and methods of distribution, the tendency of incandescent lighting and of power rates is downward, while the rates for arc lighting have not fallen so rapidly. Originally, the city lighting was, if not the only business, at least the one item necessary to the establishment of the electric plant, and this business was based doubtless upon a compromise between cost of production and what the cities felt able to pay for service. Gas competition was first met in this field, and of course, affected the rate question.

Whether or not rates originally established were equitable, any effort to increase them would be met by figures at which the municipalities could, or think they could, do their own lighting. It's a case of "charging what the traffic will stand."

RALPH R. LAXTON.

W 26. Have central stations adopted special rates for electric-sign advertising? If so, why? Does this rate vary, and on what basis?

No special rate is made except a wholesale one where the current consumption warrants it. E. A. M., N. Y. ED. CO.

Yes. This class of service keeps up the load on plant, and is produced economically. A. PETERS.

We have a special flat-rate schedule and turn lights off and on. We give a special discount on above rate to signs that do not go on until after 6 o'clock p. m. Both rates have brought us much desirable business. P. H. KORST.

Flat rates are given on signs, window lights and outlining, burning until midnight, to induce long-hour consumption and broaden the peak load. These signs and outlines are turned on and off by the company. B. C. ADAMS.

W 27. Has any effort been made to induce national advertisers to use electricity for advertising purposes? Why not make a uniform fixed rate for this class of advertising, which would apply to cities and towns of like class, so that these advertisers could include electric advertising in their appropriation the same as newspaper, bill posting and painted-sign work?

X—ACCOUNTING AND STATISTICS

X 1. (a) In a city of the first class, which has been fairly well canvassed, may it be expected that the new business now obtained will average as many lamp equivalents per customer as formerly, and that each customer will bring in as much revenue per lamp equivalent? (b) What is the average number of lamp equivalents per customer, and the average revenue per lamp equivalent?

(a) Our experience shows that the average number of lamps per consumer is increasing, due to display installations; the sales of current per lamp connected are increased from the same source.

(b) Our average number of lamps per consumer is eighteen, and the kilowatt-hours sold per 16-cp equivalent installed is forty-five. FRANK W. FRUEAUFF.

X 2. What rate of increase in 16-cp equivalents of connected installations may fairly be expected from year to year in cities of the first class?

Nine per cent. JAMES R. SHURTZ.

X 3. What rate of increase in gross income from current sales, from year to year, may fairly be expected in cities of the first class?

Eight per cent. JAMES R. SHURTZ.

X 4. What percentage of yearly increase may fairly be expected in the total horse-power of motors in connected installations? How much horse-power have you now connected?

X 5. (a) How many companies in this country exceeded 125,000 16-cp equivalents increase in connected installation in 1905? (b) What was your increase last year, and the population of the territory served?

X 6. What is your total canvassing and advertising expense per week per incandescent lamp equivalent added to your supply system?

X 7. What is the amount of population in your territory to each solicitor or canvasser? How many customers do you have to each solicitor?

The population of Brooklyn, June 1, 1905, was 1,358,891. The population to each solicitor at that time was 135,889, and the number of customers to each solicitor 656.

THE BROOKLYN EDISON, E. W. PHILLIPS.

X 8. What is the average number of 16-cp lamp equivalents of new business obtained per year for each solicitor or canvasser?

The average number of 16-cp lamp equivalents in new business obtained, and credited to each solicitor, per year is approximately 25,000. THE BROOKLYN EDISON, E. W. PHILLIPS.

X 9. For a city of the first class, what is a fair average income from the sale of current per kilowatt-hour billed for commercial service, light and power? How is six cents?

Six cents appears low for cities in the eastern part of the United States. There are a number of factors that enter into the cost, the particular one being coal. Seven cents would be a fair rate for cities with steam-coal costing $2.75.

JAMES R. SHURTZ.

X 10. What is the best method of keeping the accounts of mixed flat-rate and meter customers?

We think it advisable to have separate consumers' registers for flat and meter-rate consumers. If absolutely desired to have flat and meter consumers together, we would suggest loose-leaf registers and have meter installation on one sheet and flat installation on another.

J. E. TANGWAY.

In all work of accounting, the number of consumers has a great bearing on the method of keeping accounts. An alphabetical list up to 600 consumers works very well. After this number is reached, consumers should be divided into districts and written in street order. Flat-rate and meter consumers should be kept together, regardless of class or service.

JAMES R. SHURTZ.

A very satisfactory way of keeping mixed flat-rate and meter consumers is to place the flat-rate consumers in the back of the consumers' ledger in alphabetical order, making a note of the page and line on which their meter charge appears. This enables you by looking at any one of their accounts to turn to their flat-rate charge in making up their total bill.

S. H. SMITH.

In the case of weekly customers we find it much to our advantage to keep accounts separate; that is, one account for the flat-rate bills and another for the meter bills. However, in the case of monthly customers, we find the best results are obtained by keeping bills all in one account and having the flat-rate and meter bills fall due at the same time.

GEO. E. BURNS.

X 11. Should ledger be written up according to meter reader's route or alphabetical order of streets?

In a company of any size time will be saved in having the ledger follow the meter reader's route. In smaller companies it is more convenient to index by consumers' names.

FRANK W. FRUEAUFF.

We believe consumers' ledgers should be written up in circuits—that is, divided up according to the circuits of the distribution system—and the circuits in alphabetical order of streets. Meter readers' cards arranged similarly. J. E. TANGWAY.

See answer to X 10. JAMES R. SHURTZ.

The writing up of the consumers' ledger according to meter reader's route is very unsatisfactory for the following reasons:

First—In the event of changing the clerical force it is extremely hard for new man to find consumers' names.

Second—It is almost impossible to leave the proper spacing for your new consumers.

The entering of consumers' names according to the alphabetical order of streets has a little the advantage over the former, because the names of the consumers are more easily found.

The writer has found, in companies where consumers number from 1500 to 2000, that the alphabetical order of consumers is a much better arrangement for these reasons:

First—Any one may in a moment find any consumer, and this very often is of great advantage to the manager or superintendent who might like to look up an account for various reasons of his own.

Second—Names can be entered without leaving spaces in between, which means fewer pages and fewer totals to carry forward in balancing ledger.

Third—There are few cashiers who have not been greatly annoyed by a number of consumers coming in on discount day during the rush without their card. In some cases they have three or four locations where they are using current. How much less likely you are to miss an account, and how much faster you can find his total bill if you have to turn to but one page in the ledger than if you have to hunt them up in the several different meter routes. The writer, having used both arrangements of the ledger, has found the alphabetical entering of consumers in the ledger, taking all things into consideration, the quickest.

The addressing of the bills should, of course, be according to meter readers' books, with the ledger folio and line plainly put on; this can be done very rapidly with an addressing machine and with no chance of mistakes. After the bills are completed they should be sorted according to ledger folio and line and entered in ledger. The assorting of these bills can easily be done at the rate of 800 an hour, so while it takes some little time to do this, much more time is saved each month in the looking up of accounts alone. S. H. SMITH.

The ledger should be written up according to the meter readers' routes. This is especially true where meters are read on each working day of the month, and bills fall due ten days after date of being rendered. In this way bills falling due on a certain day each month will be found all together in the ledger, and collections will be facilitated. GEO. E. BURNS.

Ledger should be written up according to meter reader's route.

(Concurrent opinions expressed by P. S. YOUNG, G. H. CUSHMAN, F. C. S., MALDEN ELECTRIC CO., R. N. KIMBALL.)

X 12. When lighting accounts are billed at a net rate, what means can be suggested to insure or induce prompt payment?

Establish a rule that will say in few words, *Payment for current is due on the fifth of month following consumption. Any consumer in default of payment by the tenth is liable to have meter disconnected.* On the fifteenth a polite letter should be addressed to each of the delinquents and on the twentieth it should be followed up with another and collector should call as soon after as possible. If collection is not made, it should be reported to the office and the credit then passed upon as to whether current should be disconnected or balance allowed to continue until next month. JAMES R. SHURTZ.

Bills can be made out at the gross amount, then the discount deducted, leaving the net amount. A hand printed *in red* and pointing to the gross amount tells the customer that *that* is the amount of the bill. The bill should also state that the discount will be allowed if the bill is paid within a certain time. The net amount may be entered in the ledger instead of the gross, as in most cases the discount will be deducted. In cases where the gross amount is paid the discount can be charged on the ledger against the customer. F. ELLWOOD SMITH.

Lighting accounts should not be billed at the net rate. Make out the bill at the gross rate, and on the last line put, $...... *will be accepted if paid on or before the tenth.* J. E. TANGWAY.

We give 10 per cent discount if bill is paid on or before fifth of month. A. PETERS.

Promptness and regularity in the delivery of bills, together with a properly-organized collection department, will prevent delinquent accounts. P. S. YOUNG.

X 13. Have you used the Hollerith system of tabulating and summarizing earnings, and with what success?

We have had the Hollerith tabulating machines installed in our office for over a year and we have been able to obtain very satisfactory results in analyzing our revenue.

The principle of the system is to transcribe the elemental facts in detail to punched cards, to assemble the cards in the groups required and then to obtain the total of the various quantities and amounts on the cards by passing them through the electrical tabulating machine.

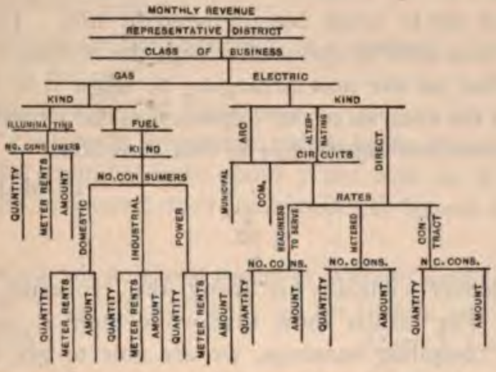
In this work the cards are punched from the consumer's bill, one card representing a gas sale and one an electricity sale, each card bearing descriptive facts, the quantities and amounts belonging to that sale.

The cards are punched in machines something on the order of a typewriter in construction.

The accompanying diagram shows the different subdivisions into which we subdivide our revenue each month.

The representative districts, of which we have fourteen. The class of consumers, of which there are nine: Residences, saloons, hotels and restaurants, manufacturers, drug stores, stores, offices, municipal and company buildings and miscellaneous.

We analyze the entire revenue in the fourteen representative districts, not only classifying according to different kinds of gas and electricity, but also according to the revenue derived from each sold to each class of consumers.



SUBDIVISIONS OF MONTHLY REVENUE OBTAINED BY USE OF THE HOLLERITH SYSTEM

We also obtain the number of each class paying meter rent and minimum electric bills, the number of kilowatts and cubic feet and the amount of money under each rate of each class of consumer, also the number of consumers in each case.

In addition to this analysis, we obtain an analysis of gas sales, showing the number of consumers using less than a thousand cubic feet of either kind of gas in a year—shown in both quantity and amount—the number of consumers using less than two thousand, less than three thousand, and so on. We also obtain the same kind of an analysis of the electric revenue.

V. A. HENDERSON.

This company has used the Hollerith system of tabulating and summarizing its earnings for over two years, and finds it an extremely useful adjunct to its accounting department equipment, and for the following reasons: It is economical, in that it enables us to do with low-priced female labor what we formerly did with high-priced bookkeepers. There is no limit to the amount of analysis that we can obtain by its means, for, as the system includes a card for each bill rendered and an automatic adding device, any refinement of analysis can be obtained by simply grouping cards of a similar nature and footing them in the machine separately. It also acts as a safeguard from a bookkeeping point of view, in that the determination of the sales is not in the control of the employee having the accounts in charge, and therefore affords the company a check on his work by requiring him to prove up to totals not prepared by him. Thus far, the system has been used in connection with the revenue of the company only, but we are now arranging to adapt it to use in connection with the analysis of our expenses, as our experience shows that it has abundant capabilities in that direction.

H. M. EDWARDS.

The Denver company is using the Hollerith system of tabulating. The results show that while there is no saving in the cost of compiling earnings, we are able to get much additional information without cost. We now secure a separation of earnings on each circuit, on each class of business, at each rate, and in each district in the city, without additional work.

FRANK W. FRUEAUFF.

We have decided to use this system for tabulating and summarizing earnings, and so forth, but it will not be put into use before July first, next. L. M. WALLACE.

X 14. What is the proper method or custom, in case of an established light and power plant, in making the books correct to show the true relation between capital account and net income?

X 15. Has the depreciation charge on the various classes of apparatus making up the complete equipment of electric companies been standardized?

While the depreciation charged on the equipment of electric light companies has perhaps not been standardized, the matter has been gone into many times, and at so many different places, that a pretty fair agreement seems to have been reached. Massachusetts and Connecticut fixed the charge by statute for municipal plants at 5 per cent on the cost of the plant, which presumably includes land.

Investigators, boards of arbitration and engineers that have reported on this subject seem to arrive fairly unanimously at about the following figures:

Buildings and similar fixtures, 2 to 4 per cent.
Boilers, 10 per cent.
Steam equipment, 5 to 7 per cent.
Electric equipment, overhead, 10 per cent.

The latter running from about 7 per cent on wire, 10 per cent on poles, *et cætera,* to 15 per cent on lamps, hangers, *et cætera.*

Allowance made as above seems to average with considerable uniformity at 7 to 7.5 per cent on the whole equipment exclusive of land.

ALEX J. CAMPBELL.

The subject of depreciation is a very hard problem to make one rule apply to, as various station equipment is changing so rapidly that the depreciation should be based on each station. It should be arrived at by subdividing the station into such parts as foundations, buildings, boilers, piping, electric machines, switchboards and wiring, and carefully estimating the life of each item. From this a fair depreciation should be readily determined.

JAMES R. SHURTZ.

No. It should be done to use against municipal ownership.

R. N. KIMBALL.

X 16. In charging depreciation on electric plants, what is the best method of arriving at the correct amount charged? Should the amount be a percentage or should it be a percentage of the structural value, and, if so, how arrived at?

The percentage should be based on the life of the various buildings and machinery. Should be arrived at by estimate made by a competent engineer. It would be well to have an estimate from two different parties, taking the average.

James R. Shurtz.

Percentage of the structural value would be the proper figure to take, arriving at this percentage by taking each piece of apparatus separately.

P. S. Young.

X 17. Is it correct in substituting new equipment for old, either worn out or inefficient, to charge the new equipment against capital account when the change is in the nature of repairs or for more efficient machinery?

It is not correct in substituting new equipment for old or worn out to charge same to capital. We believe it proper to charge same to repair account, crediting this account with anything that is received from the sale of such old machines. We believe a proper method is to charge each month a certain amount to operation, crediting same amount to some contingent fund.

J. E. Tangway.

Only the difference should be charged against capital account, represented by the cost of the new equipment against the original cost of the old equipment displaced.

James R. Shurtz.

New equipment to take the place of old should be charged as a maintenance and not as a capital account—in other words, as a repair.

A. Peters.

These should certainly be charged to operating expenses.

F. Ellwood Smith.

No; capital account should only be charged with the excess cost of new equipment over the value on the books of that which it replaces. P. S. YOUNG.

X 18. What percentage of the gross income of an electric light company should with propriety be spent on analytical and statistical work in order that the business may be thoroughly known in each and all of its details rather than lumped in under the usual general headings; as, for instance, Expenses up to the Switchboard, Distribution Expenses, Management Expenses, etc.?

In operations of small magnitude the manager, or operating head of the company, should be able to subdivide the work into the various costs, which it is absolutely necessary for him to know in order to sell his production at a fair return on the capital. In large operations, it is absolutely necessary to make divisions, and from three to five per cent of the gross receipts might be properly spent in this work. JAMES R. SHURTZ.

***X 19. What is being done toward obtaining a uniform and accurate system of classification of accounts?**

***X 20. What is best, cheapest and most up-to-date method of keeping stores?**

The best method of keeping stores must necessarily be determined from the size of the store and the requirements. In operations where from ten to one hundred thousand dollars' worth of material is kept in stock, accounts should be so arranged that each article delivered would be issued on a small delivery card, three by six inches. These delivery cards should be assembled either each day or at the end of a short period, and at the end of the month charged out at their unit value. Returns to stores should be taken care of by using the same card made of different-colored cardboard. A stock-ledger ruled especially for this work should be adopted, and, where practicable, the balance on the ledger should be verified at least once in two months with stores in stock. Stores should be kept in such shape that they are under the supervision of one man and he be held responsible.

JAMES R. SHURTZ.

A book or card record, according to individual preference, of each class of material, from which a balance can be taken off to agree with the general ledger, is generally accepted as the only proper way to keep a store account. P. S. YOUNG.

***X 21. In keeping stock is it best to give each class of articles a serial number to be used instead of name, similar to systems used by railroads? Give reasons.**

In some stores it is found desirable to use the number in addition to articles used. A system whereby the number is the page number of the stock ledger lends a great deal of aid. The number scheme should be applied to the part of the stores where best adapted. JAMES R. SHURTZ.

X 22. In a large electric light company, is it sufficient to carry the operating accounts and other accounts forward month by month with simply the detailed items of expenses and fixed charges, or does it pay to carry also a supplementary analytical statement, developed under the headings of the various major functions governing the business; as, for instance, Output Costs, Customer Costs, Demand Costs, Reserve Capacity Costs, etc.?

In large operations these results are absolutely necessary, especially where the amount of profit is small. If these matters are not cared for, it leads to wastefulness and non-attention of operating managers. The operating department should have at as early a date as possible after first of each month sufficient information to enable them to become thoroughly acquainted with their costs, and if comparisons can be obtained benefits must accrue to the company. JAMES R. SHURTZ.

X 23. What is the ratio in your plant between the kilowatts of maximum peak load and the kilowatts of total connected installations?

In December, 1905, 41.2 per cent. L. L. ELDEN.

Forty-three per cent. A. PETERS.

X 24. What is the load factor in your plant on the day of maximum peak winter load; that is, the ratio between kilowatts at the time of maximum load and average kilowatts?

Fifty for 24-hour service. R. N. KIMBALL.

Output 27,672 kilowatt-hours, average 1153 kilowatts, peak 2440 kilowatts. Load factor 47.2 per cent. C. W. HIGGINS.

In December, 1905, 42.5 per cent. L. L. ELDEN.

Fifty-seven per cent. GEO. N. TIDD.

X 25. Taking as a basis your maximum peak load in kilowatts and your annual station output in kilowatt-hours, what is the equivalent number of hours' use per year of your maximum load?

Annual output 6,544,000 kilowatt-hours, peak 2440, equivalent to 2682 hours' use or seven hours and twenty-four minutes per day. C. W. HIGGINS.

Two thousand four hundred and twenty-one hours.
L. L. ELDEN.

X 26. What is the ratio in your plant between the peak load in kilowatts on the week of smallest average peak load and the week of heaviest average peak load; that is, comparing your summer and winter loads?

Smallest average peak 1727 kilowatts, maximum peak 2440 kilowatts. Summer peak is 70.7 per cent of winter peak.
C. W. HIGGINS.

Thirty-three and a half per cent. S. R. INCH.

X 27. What is the ratio in your plant between the kilowatt-hours during the week of smallest station output and the week of largest station output; that is, comparing your summer and winter loads?

In December, 1905, 44.5 per cent. L. L. ELDEN.

Smallest week's output 94,660 kilowatt-hours; largest week's output 175,907 kilowatt-hours. Summer load 53 per cent of winter load. C. W. HIGGINS.

Forty-one and a half per cent. S. R. INCH.

X 28. What is the ratio in your plant between the total kilowatts of meter capacity and the total installation or maximum load—eliminating, of course, that part of the installation or maximum load that is not supplied on a meter basis?

Ratio to total installation 81.5 per cent. Ratio to maximum peak load 192 per cent. S. R. INCH.

X 29. In a plant with a monthly output of 200,000 kilowatt-hours, what percentage of this current should be lost, including current stolen and unaccounted for, under the following conditions? 63,800 kilowatt-hours of the above total is the output, measured on the alternating-current end of a rotary converter, changing from 2300 volts alternating current to 500 volts direct current. Primary voltage, 2300; secondary voltage, 110; 700 induction meters of the latest type; 600 T. R. W. commutator-type meters; 190 G. E. transformers, ranging from 6 to 15 kilowatts; no secondary or primary wire smaller than No. 8, and the copper as a whole not loaded beyond its carrying capacity; 208 G. E. series street arcs, nominal 2000-cp operated by means of three tub transformers; the output of the rotary above mentioned, for motors exclusively; no alternating-current motors?

Twenty-six per cent. A. T. LLOYD.

In the operation of a plant of very approximately the same output, and with a seven-mile, three-phase transmission line, our

total loss from generators to consumers, including that due to slow meters, theft of current, *et cætera*, is approximately 27.5 per cent.
S. R. Inch.

X 30. What is the average percentage of lamps lost per year to lamps gained among the larger companies? In other words, to every 100 lamps connected how many are disconnected?

The records of this company for the calendar year ending December 31, 1905, indicate disconnected lamps equivalent to 63.5 per cent of the number of lamps added. The number of lamps disconnected during this period is exceptional, and is not treated as the average percentage of disconnections to lamps added, as included in this disconnected percentage are several large installations that were removed to New Jersey and other locations. The percentage of temporary season disconnections at Coney Island during this period was in excess of that for connections, due to a number of larger installations having been partially connected in the latter part of 1904 for erection purposes. The average disconnections for the past several years is about 50 per cent of the lamps added.
The Brooklyn Edison, E. W. Phillips.

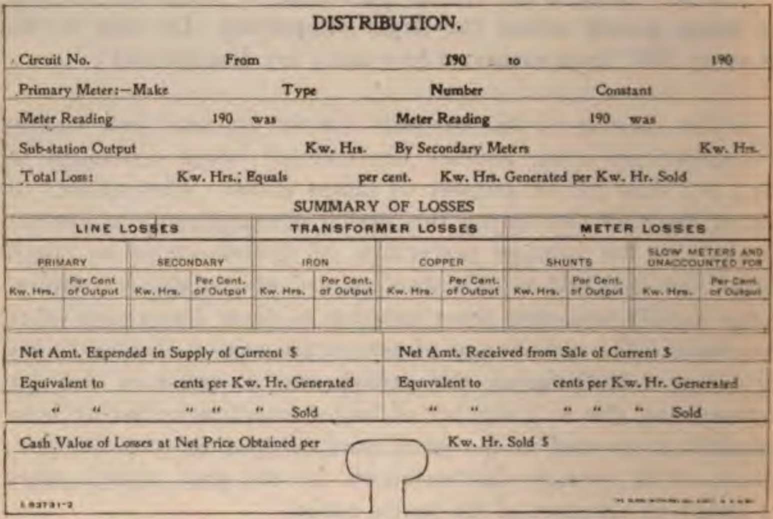
About one lamp disconnected to every three added.
B. C. Adams.

X 31. In a city with population of 70,000 and no gas competition, what would be considered good results as to total connected lighting load per capita expressed in 16-cp equivalent?

Birmingham, Ala., has 1.35 lamps per capita.
Birmingham Railway, Lt. and Power Co.

X 32. What methods are in use for systematically and regularly ascertaining the various distribution losses?

We meter the total output of station, the output of each feeder and the consumption of each customer. In this way we arrive at the total losses for each circuit; the transformer and meter-shunt losses are readily secured and the line losses can be closely approximated. The balance of the losses is that due to slow meters, theft of current, *et cætera,* and represents the preventable loss.



DISTRIBUTION.

Circuit No. From 190 to 190

Primary Meter:—Make Type Number Constant

Meter Reading 190 was Meter Reading 190 was

Sub-station Output Kw. Hrs. By Secondary Meters Kw. Hrs.

Total Loss: Kw. Hrs.; Equals per cent. Kw. Hrs. Generated per Kw. Hr. Sold

SUMMARY OF LOSSES

LINE LOSSES				TRANSFORMER LOSSES				METER LOSSES			
PRIMARY		SECONDARY		IRON		COPPER		SHUNTS		SLOW METERS AND UNACCOUNTED FOR	
Kw. Hrs.	Per Cent of Output	Kw. Hrs.	Per Cent. of Output	Kw. Hrs.	Per Cent. of Output	Kw. Hrs.	Per Cent. of Output	Kw. Hrs.	Per Cent. of Output	Kw. Hrs.	Per Cent. of Output

Net Amt. Expended in Supply of Current $	Net Amt. Received from Sale of Current $
Equivalent to cents per Kw. Hr. Generated	Equivalent to cents per Kw. Hr. Generated
" " " " " Sold	" " " " " Sold

Cash Value of Losses at Net Price Obtained per Kw. Hr. Sold $

L83731-2

INDEX CARD FOR RECORD OF DISTRIBUTION LOSSES

The illustration will serve to indicate how the various data are tabulated.

S. R. INCH.

X 33. Where companies operate both lighting and railway departments from the same central station, what is the usual method pursued in arriving at the operating expenses of each? That is, does each department have its individual operating accounts, or does one department bear all the expenses and charge the other department by the kilowatt-hour at the switchboard?

Wherever practicable, items common to both departments and not otherwise separable, such as fuel, water, oil, station attendance, *et cætera,* should, I think, be distributed on basis of recorded kilowatt-hours.

RALPH R. LAXTON.
P. S. YOUNG.

To determine operating expenses of lighting and railway departments, we charge direct to the department concerned in so far as possible, and where impossible to do this, pro-rate on a basis of kilowatt station capacity, kilowatt-hours, and gross earnings. T. H. T. & L. Co.

We divide all station operating expenses at the end of each month between the railway and lighting accounts in proportion to the kilowatt-hour output.

BIRMINGHAM RAILWAY, LT. AND POWER CO.

When operating both lighting and railway departments from one station, the most accurate method of accounting would consist of three separate and distinct departments; the station or manufacturing department, the lighting department, and the railway department; the station selling its output to the other two by meter cost, cost at the station includes all its operating expense, taxes, insurance, depreciation, and a portion of the office expense and superintendence. HERBERT MCNULTA.

X 34. On a system operating several water-power and steam plants, all connected to the same transmission line, steam plants being run over the peak load only, what is the best method of arriving at the cost per kilowatt-hour water-power as against steam? In connection with this it must be borne in mind that fires are kept up under boilers of the several steam plants for emergency purposes, and a sufficient number of men kept on duty continually to operate the steam plants in case of breakdown anywhere on the line. There is a certain amount of fuel and labor expended, which is neither actual steam operation nor water-power, but simply insurance in case of accident. In addition to this, there is certain attendance on transmission stations all along the line, and current may go into these stations from water-power or steam sources.

In our water-power stations we have recording wattmeters on each generator panel of the switchboard. At the end of the month we take the total of what the machines have done and divide the total cost of labor, maintenance, *et cætera*, by same.

We do the same in our steam-turbine plant, and while the cost per kilowatt-hour is high on account of the small output and large coal consumption, we consider it the only fair way to do.

UNITED ELEC. LT. CO.

Any estimate can be but approximate. Estimate labor and fuel expended at steam plants when not delivering current as stand-by expense. Deduct this cost from steam-plant operating expense and figure cost per kilowatt-hour on each class of power service according to output. Then to each figure of kilowatt-hour cost add the stand-by cost per kilowatt-hour, being the total steam stand-by cost divided by the entire output of all stations. This will give only an approximate comparison of costs. The actual cost per kilowatt-hour for use in making rates should be operating costs of all plants divided by the total output.

HERBERT MCNULTA.

About the only way would seem to be to charge each station with the cost of operating it and credit it with kilowatt-hours output, then add to the cost of production by water such amount of steam expense and attendance as would be charged if you were maintaining only. Steam plants should be credited with amounts thus added to water-power cost. Substation and line expenses could then be distributed between steam and water on basis of recorded kilowatt-hours developed by each.

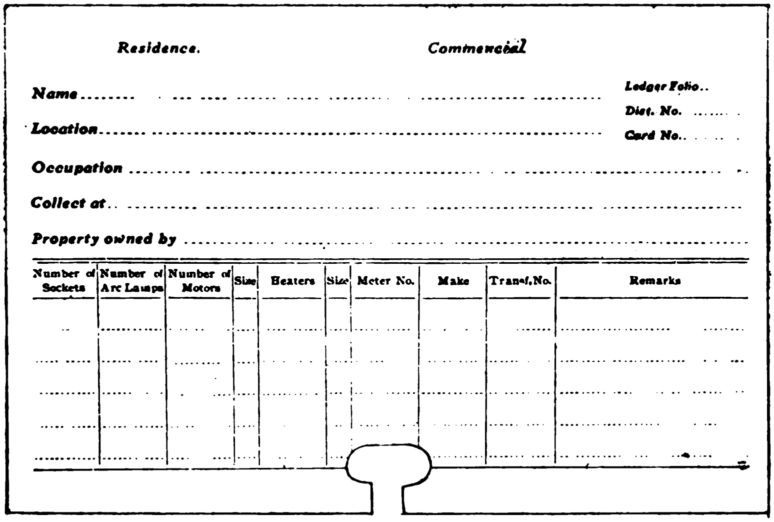
RALPH R. LAXTON.

X 35. What is considered the maximum percentage of operating expenses to income at which a medium-sized electric light plant can show a fair return on the investment?

X 36. Give good form for meter cards and customers' index, for use in small stations.

We have found the cards illustrated below very useful and think they may be of benefit to some other members of the association.

These cards are particularly adapted for the smaller stations. The meter card is taken from the cabinet and placed in a card holder and used by the meter reader. It is then placed in the file from which the bills are made. The other card is the customers' index and can be used as a general information bureau.



Residence. *Commercial*

Name ....

Ledger Folio..

Dist. No. ....

Card No.........

Location..

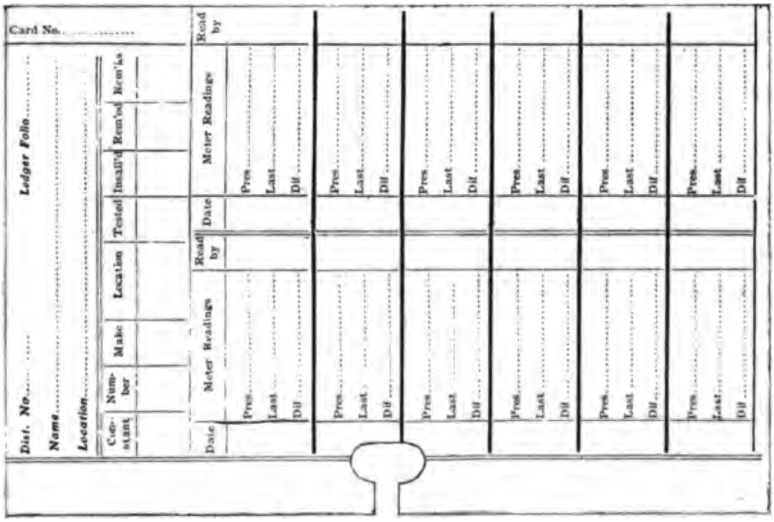
Occupation..

Collect at..

Property owned by..

Number of Sockets	Number of Arc Lamps	Number of Motors	Size	Heaters	Size	Meter No.	Make	Transf. No.	Remarks

CUSTOMER'S INDEX CARD



Card No. ....

Ledger Folio........

Dist. No.........

Name..

Location..

Con-stant	Num-ber	Make	Location	Tested	Install'd	Rem'ed	Rem'ks

Date	Read by	Meter Readings
		Pres......... Last......... Dif.........
		Pres......... Last......... Dif.........

METER READER'S CARD

L. E. WATSON.

Y—MANAGEMENT

Y 1. What are managers in small towns doing to compete with the gasolene proposition?

We have strong gasolene competition, our town being the home town of the American Gas Machine Company. We keep talking to the public about gasolene danger, odor, dust, inconvenience, *et cætera,* but the very low cost of gasolene light impresses them more than do the drawbacks of the light.

LUDWIG KEMPER.

Use Nernst lamps. C. K. MUNNS.

In small towns, perhaps more than in large ones, one sees the bad use of incandescent lighting. It is not at all unusual to see a row of bare lamps hung over the counter on each side of the store, which furnishes the entire illumination. Many towns are now waking up to the fact that simply to put so much light in a store or room is not sufficient and that the customers are paying, not so much per kilowatt-hour, but really for illumination. In order, therefore, to compete with gasolene, such electric light companies are paying especial attention to illumination, so as to give the customer the best possible service for the money.

VAN RENSSELAER LANSINGH.

By advertising, showing the danger and disadvantage of gasolene. We recently had some gasolene competition and successfully got it out of the way by advertising in the newspapers, inserting clippings of gasolene explosions in different parts of the country, sending out pamphlets describing explosions, calling attention to the bad smell which always comes from the use of gasolene for lamps and the necessary attention any gasolene plant requires. P. L. UTLEY.

***Y 2. How small a town will justify the building of an electric light plant?**

We have only a 100-kw outfit, which has never run overloaded. We have been in business for seventeen years, net dividends for that time averaging after all expenses, renewals of equipment, and expenditures for new machinery, 10 per cent per year. Town is wired for about 4000 16-cp equivalents. Inhabitants, 3000. FRANK BECKWITH.

In the installation of electric light plants, not so much depends on the size of the town, as on the character of the dwellings and the possibilities of supplying power and current to manufacturers. We have had successful operations in first-class resident towns of some 2000 population and upward. In another location where the town was situated twenty-five miles from a city of any size and the community was dependent on farming districts, which had a population of over 5500 people, the plant would not earn a very large return on the capital.

JAMES R. SHURTZ.

Y 3. What conditions should be taken into account in determining if a day load would pay in towns of from 2000 to 10,000 population? Also, what conditions should govern the price of current for power to be sold to several large consumers in order to assist day load?

A day load in a town of from 2000 to 10,000 population would depend entirely upon the amount of power load obtainable.

The price to be charged for day-load service would depend upon the cost of producing the extra current and rates could not be materially lowered in case the output were so small that the additional cost of a day shift of attendants would constitute a heavy percentage of total cost of production.

JAMES R. SHURTZ.

The amount of power business available. The price of current should be governed entirely by the character of the load and the generating costs. GEO. N. TIDD.

The net cost of carrying day load including interest on duplicate apparatus necessary to insure continued service, and the probable amount of power business to be had.

Large customers will have to be taken at a rate that will justify them in discontinuing their existing arrangements for power, but should not be given a rate that does not show a profit. Otherwise, they will become burdensome when the opportunity offers to load your plant with smaller customers at a living rate. You have also to reckon with the tendency of large-users of power to honestly underestimate the cost of maintaining and operating their own plants. RALPH R. LAXTON.

Y 4. On what sized plants in cities of from 2000 to 10,000 is it better to install meters in preference to flat rates?

Install meters. Flat rates are not known to good business methods; it's guesswork, therefore could not be just to either the customer or the lighting company. A meter is a device or means for weighing or measuring the goods or product of your plant. All manufacturing concerns pay especial attention to the amount given for a fixed value. Try it; whether the town be small or large, it will pay. W. W. FULLER.

Have both flat and meter rate. Work the meter rate, but if your customer says "I don't know anything about how much light I can get for a kilowatt-hour," refer to your flat rate and say "Wire up and try a meter. If you think it is too high, I will run the lights in this room for (having figured it out) so many dollars per month." It catches 'em. L. W. GREENE.

See answer to W 7. LUDWIG KEMPER.

On any size contemplated. No plant too small for meters.
FRANK BECKWITH.

(Practically concurrent opinions expressed by ALEX. J. CAMPBELL, F. C. S., MALDEN ELECTRIC CO., JAMES R. SHURTZ, F. ELLWOOD SMITH, A. O. FRETZ.)

Meters are generally desirable in all plants regardless of size of town. Start right and when you reach the point where a day load is to be had, you will not be troubled by twelve-hour flat-rate customers who negligently burn lights all day.
RALPH R. LAXTON.

Y 5. Should the management of an electric light company be conducted with the same economy that it should insist upon in every other department, or should it be conducted on the lines that will give the greatest use of current by the community, minimum average price, maximum gross and net earnings and highest general efficiency, practically without regard to the specific costs of management, except that they produce the results suggested?

The management should be along the lines of greatest output, reasonable price, maximum earnings and highest efficiency. Unless a corporation pursue an enlightened, progressive course, it will gradually become unpopular with the public, and detrimental after results may be anticipated. J. J. CAGNEY.

The management of an electric light company should be conducted on the lines of giving the greatest use of current at as low rate as will return a fair amount on the capital, as the tendency of the age is to consume more current per capita each year. The cost of management, in order to get these results, should not be allowed to run away with itself.

JAMES R. SHURTZ.

Work for the highest general efficiency. This is economy, even if it increases expenses. RALPH R. LAXTON.

Y 6. In small companies, where the station and line force consists of not more than ten or twelve men all told, is it advisable to attempt any rotation of duties for the employees, in order to familiarize them with one another's work, as a precautionary measure in case of emergency?

Yes. In these times of intense commercialism the man who has but one idea and little or no ambition to rise is generally a poor investment. Stay with the man who gladly gives a hand in any department of the work. J. H. ENRIGHT.

It is very advisable so to arrange work that at least two men are competent to handle each class of work or department, and the more men fitted to take charge of any particular line of work, the better. ALEX. J. CAMPBELL.

I think that in plants of any size it is advisable to have your organization carried out on the lines of having men familiarize themselves with one another's work, so that in case of emergency the work may be carried on with more intelligence.
F. C. S., MALDEN ELECTRIC CO.

Some attention should be given to the organization of a small force of ten or twelve men, so that in case of emergencies employees will be so trained that they will be interchangeable in different positions. JAMES R. SHURTZ.

I have found it of benefit to do so. A. O. FRETZ.

Not advisable to attempt rotation of duties, as each class of work requires long service to become proficient, and a man with only a slight acquaintance with the duties of another might make serious or fatal mistakes. C. W. HIGGINS.

No; the benefits gained would be offset by increase in maintenance cost of plant, and the chances are that your service would be ruined in the attempt. However, a school intended to accomplish the same end or result could do no harm.
W. W. FULLER.

Under such circumstances, employees should be worked in rotation, at least to such an extent as to familiarize them with each other's duties, this being done, if possible, in pairs. More efficient operation might be obtained by their not usually working in rotation, but they should work in rotation sufficiently to meet an emergency call. W. H. GARDINER, JR.

Yes. In addition to the insurance value of such an arrangement, it will generally be found that a well-rounded man is better than a specialist. RALPH R. LAXTON.

***Y 7. Would it be advantageous to establish free night schools for the employees in the manufacturing and distribution departments, to furnish a course of instruction pertaining to these departments?**

Yes, without a doubt. W. W. FULLER.

I think it a good idea for a company of any size to furnish a club-room or to help maintain a club-room for the employees, wherein they can meet and have discussions; also obtain books and supply them with the leading technical papers covering the business that would be of value to promote the general efficiency of the employees. F. C. S., MALDEN ELECTRIC CO.

Apart from purely routine manual work, the employees who know the most about their work are the most efficient. Night schools and voluntary night work, in which the heads of departments participate, are conducive to the development and support of individual effort, emulation and improvement, which will react to the benefit of the service. W. H. GARDINER, JR.

Y 8. Should either the operating or commercial departments of an electric company desirous of increasing its motor business have all consumers' apparatus, shafting and machinery inspected and tested periodically by an expert so as to reduce waste, and in this manner get in closer touch with consumers and insure their continued patronage?

Yes, apparatus should be tested when there is any reason to believe that the machinery is not operating at maximum efficiency and customer shown how changes may be made to increase economy in current consumption.

C. D. W., N. Y. ED. CO.

I think it well for the operating department to have all customers' apparatus, up to a certain point, tabulated on a card system, so as to give them intelligent assistance at once in case of trouble of any nature; the more you can help a customer out of difficulties, in emergencies, in case of breakdown or otherwise, the better impression you have made, and this will tend to insure continued patronage. F. C. S., MALDEN ELECTRIC CO.

To install a motor properly, some attention should be given to the customer's apparatus, in order that after the motor is installed he may get satisfactory results. This will satisfy the customer and you are in a position to compare the consumption with other locations and take on more business. I do not think periodical tests would be desirable after the first inspection.

JAMES R. SHURTZ.

Yes. Any reasonable expenditure that the company can make to convince a customer that the company is working to render the best service at the least cost to the customer, is advisable. W. H. GARDINER, JR.

(Practically concurrent opinions expressed by P. L. UTLEY, RALPH R. LAXTON, P. S. YOUNG.)

***Y 9. Is it not desirable to have application and complaint departments as part of the commercial department, or handled by men trained in the commercial department, because of their familiarity in dealing with the public?**

Application department should form a part of commercial department. No up-to-date corporation should countenance any department designated a "complaint department," as its presence would be an admission that you had so many complaints that you established a special department to handle same. See that your operating departments are in such a state of efficiency that complaints are a minimum. J. J. CAGNEY.

It is desirable to have the complaint and commercial departments acquainted with as many peculiarities of the distribution department as possible, in order to allow them to satisfy the public and be able to give satisfactory answers to applicants and complaint work. JAMES R. SHURTZ.

It certainly is desirable to have application and complaint department as part of the commercial department. The men for complaint work should be trained especially for this, and should be of such good address that they can meet people in all grades of society upon an equal footing.

W. R. B., N. Y. Ed. Co.

Yes; the commercial department should really have charge of all matters directly pertaining to the public.

W. H. Gardiner, Jr.

Yes, maintaining always a thorough sympathy and understanding between this and the operative department.

Ralph R. Laxton.

***Y 10. What method should be used with consumers who are chronic kickers—people who come to the office every month with a complaint?**

Complaints from chronic kickers are likely to cause one to lose one's temper. Take it easy and let the kicker run down, which he will usually do after abusing you through the company. Be an "oyster." Same when office knows nothing about the circumstances. Then find out where you are "at" in regard to the correctness of the meter. If right, you are prepared to handle the case as the personal equation seems to dictate. Sometimes I have found it very advantageous to wade right into a bad kicker and shut him up. But it has a bad effect, as he always claims to have been gentlemanly, and one may get fired for it.

Frank Beckwith.

Try to convince them, be very patient with them, and if all that fails, suggest to them that they discontinue using light. It is better to be without chronic kickers, because they can do a lot of harm. Usually, however, a suggestion of discontinuing the use of light quiets them down for awhile. Be sure, however, that your bills are right. Ludwig Kemper.

Catalogue their names and successive complaints, do all you can to reconcile them, and if they remain unreasonable adhere strictly to terms of your contract, after pointing out that you have exhausted all efforts to satisfy. J. J. Cagney.

The chronic kicker is somewhat imaginary and should not trouble a properly organized company. By taking every complaint seriously and giving it prompt attention, a chronic kicker will soon disappear. Human nature has to be dealt with—each case on its own particular lines. JAMES R. SHURTZ.

Grin and bear it; the former internally, the latter externally. WARREN PARTRIDGE.

Frankly tell the customer that repeated investigation proves no error and unless there appears to be some decided ground for complaint you consider the account correct as rendered. This should not be done, however, unless you are absolutely sure of your facts. W. R. B., N. Y. ED. CO.

Investigate their complaint each time and endeavor, if possible, to reduce their consumption of current by suggesting rearrangement of lamps, shades or other conditions, which can be readily determined by a good complaint man on the premises. GEO. N. TIDD.

It is fatal to allow a chronic kicker to think that you consider him a chronic kicker. If each time he is treated as though his complaint might have some foundation in fact, but upon consideration has not, and this later is proven to him insofar as possible, he may get tired of making a fool of himself. Otherwise, he will merely think he has additional cause for complaint in not receiving proper attention. W. H. GARDINER, JR.

The manager or superintendent should take an active part in the handling of complaints.

The public generally likes to reach the "boss" direct. He should have referred to him complaints with which the office force is unfamiliar and should personally meet the kickers and see that they get a "square deal." If the customer is not utterly beyond redemption, an honest man doing his best will eventually win his sympathy and make him a friend.

Personal experience has taught me that this method is infinitely better than a system of handling complaints by proxy. RALPH R. LAXTON.

They should be given the same courteous treatment as every other consumer. A little special attention will probably take them out of the class mentioned. P. S. YOUNG.

Patience and courtesy. H. A. STRAUSS.

***Y 11. When the office force at the complaint desk knows nothing about the circumstances, what is the best and most satisfactory way of handling complaints in regard to high bills?**

(1) Compare bill with previous month, which should have been done before bill was delivered.

(2) Compare with same month for year previous.

(3) Order meter reread.

(4) Order meter read to get amount used in twenty-four hours and from this compute monthly bill for comparison.

(5) Order meter tested.

(6) Adjust complaint in accordance with the data derived as above. F. M. VANDER VOORT.

(1) The customer should be treated with the utmost courtesy.

(2) Customer's complaint should be taken down and he should be advised that the entire matter will be investigated carefully, and upon completion of the same that a reply in detail will be sent. W. R. B., N. Y. ED. CO.

See answer to Y 10. RALPH R. LAXTON.

The party to whom the bills are paid should be competent to handle complaints of this nature, otherwise it should be referred to the manager. There is nothing more important than to handle this line of work properly J. H. ENRIGHT.

***Y 12. What is being done to convince people of the company's proper relation to the public? Will publicity be of advantage in this connection, and what will be of the greatest value in convincing the public that they are getting full value for what they are paying?**

Best known method would appear to be the dissemination of literature in the form of a monthly bulletin through which medium much of the prejudiced misinformation emanating from sources of malice could be removed from the public mind. Publicity, in conjunction with tactful, courteous treatment of consumers, is certainly the only means of achieving the desired result. Again, by drawing comparisons between rates obtaining elsewhere, and, generally speaking, putting "above board" all intercourse with the public, the controlling element will gradually but surely become satisfied that it is getting its money's worth. J. J. CAGNEY.

A literature campaign should be established in communities that are large enough to support same. Bureaus that distribute matter touching on this subject to smaller companies at a nominal cost are in operation in large cities. JAMES R. SHURTZ.

See answer to Y 10. RALPH R. LAXTON.

It is essential that public-service corporations maintain proper relations with the public, and important that the public be shown the good faith of the company in all its transactions. The establishment and maintenance of cordial relations with all customers through a broad-minded policy of business conduct will go far toward convincing the people generally of the company's good will and fair treatment. Publicity, however, may be used to decided advantage in announcing broad policies and bringing to the attention of the public at intervals, and in a forceful manner, information bearing upon the relations of the company and the public. No amount of publicity, however, will successfully counteract the effect on the public resulting from unreasonable-minded policies or unsatisfactory service.

THE BROOKLYN EDISON, W. W. FREEMAN.

Nothing will be so helpful in impressing upon the public the desire of the company to maintain a friendly attitude as the demeanor and the bearing of the individuals who come in contact with the people. Publicity is of course advisable, but if the action of the employees and representatives of the company does not conform to the advertised policy, the public will feel that the announced policy is a subterfuge and is not to be carried out.

This answer, of course, presumes that the company is delivering the best service possible to the community, but the former is necessary quite as much as the latter. C. A. L., N. Y. Ed. Co.

An able commercial department with first-rate district representatives is the best means of accomplishing this end.
W. H. Gardiner, Jr.

See to it that every employee treats the public in a fair way. Educate the public as much as possible, but start by educating the newspapers, give them all the information with good business judgment. A small news item once in a while will be appreciated by the editor and he will be inclined to be your friend.
Ludwig Kemper.

Give them all they can stand in the way of publicity about your meters of all kinds and prove to them that you are absolutely honest in the matter. H. E. Ryder.

***Y 13. Has the granting of a percentage of their gross earnings by many companies throughout the country to their respective cities had a tendency to subdue municipal ownership agitation?**

Yes; the practice where employed has had a most soothing effect, for it is well known that such percentages generally far exceed any profits, seldom if ever realized, from municipal operation. J. J. Cagney.

I do not think that the granting of percentage of gross earnings has had a great amount of effect on the subduing of municipal ownership agitation. At this time there is a wave passing over the country. The most effective plan of combating this is reducing the price charged cities for municipal lighting, so that there is not an unfair comparison between municipal operation of plant and private corporations. James R. Shurtz.

Yes, but this policy is open to grave question.
W. H. Gardiner, Jr.

***Y 14. What is the proper basis for taxation and how shall it be reckoned? What is the practice in your company and state, and if inequitable, why is it so?**

The proper basis for taxation should be the assessing of each class of property at its full value. This should have a tendency to reduce the tax rate. The practice in New Jersey is to tax the gross receipts two per cent, and physical property is taxed by local assessors, the percentage of values varying in different locations. The method would be equitable if all physical property were assessed at its true value. The two per cent tax on gross receipts is now divided among the municipalities in accordance with the total length of street occupation, of either gas, electric or railway lines. It should be divided on two per cent of the actual receipts in every municipality.

JAMES R. SHURTZ.

Y 15. Under what circumstances do you consider small two-story residences as desirable customers?

The greater part of our business is with occupants of small two-story houses. This class of customer usually comes on at peak of load, but to compensate this we charge twenty cents per kilowatt-hour with no discount for prompt payment. Minimum rate of $1.00 per month whether meter records that amount or not. We have found this class of business satisfactory.

FRANK BECKWITH.

If the rates take into account the number of hours' use of the maximum, and if a guaranteed minimum is required, small two-story residences should always be desirable customers; with the possibilities of introducing heating appliances, this class of business will undoubtedly pay much better in the future.

B. J. DENMAN.

We want as many of them as we can get.

LUDWIG KEMPER.

I believe it desirable for an electric light company to add, as far as possible, small customers to their load, but in order to get such customers it is necessary to give them the best service for a minimum cost, as otherwise they would surely use gas. For example, in Flatbush, Brooklyn, N. Y., practically all two-family houses, as well as small single houses, are using gas; the houses not even being wired for electricity. If the customer or tenant could be convinced that electricity could be furnished for anywhere near the same cost, a large number of customers could be secured. With the present wasteful method of using electric light, however, this is impossible, and it means that we must educate the customer up to the knowledge that electricity can be used more cheaply and economically by means of proper illuminating engineering. VAN RENSSELAER LANSINGH.

Every store or house, no matter what the size, should be considered a desirable customer. Of course the larger the customer, the better the management would appreciate such an installation, yet the small customer should not be overlooked, and he should be sought quite as much as the large customer.

C. A. L., N. Y. ED. CO.

Under practically all circumstances surrounding the central-station business to-day. The average citizen is generally a desirable customer. RALPH R. LAXTON.

Y 16. What has been the best plan for closing down isolated plants in large cities where steam is required to heat buildings?

If there is a district-heating system in operation it aids very materially in closing down isolated plants in large cities where heat is required. B. J. DENMAN.

Y 17. Supposing a competing company establishes a supply system generally through your territory, what is the best policy to pursue in handling your existing business and the competition generally?

Unless the competing company divides the territory with the existing company, it would be a short time before the two companies were operating as one. The policy of handling existing business can be determined only on what the competitor's plan is. You naturally have to follow the competitor's lead.

JAMES R. SHURTZ.

Give the best service possible, and in every case be a little ahead of the other fellow. C. A. L., N. Y. ED. CO.

"Square deal" again, and "trouble hunting" whenever trouble is reported or suspected, with a view to eliminating the trouble. Beat the other fellow in service if you can; avoid cut-throat policies, and, if he will allow it, be on good terms with your competitor. The other fellow may be honest and yet be guilty of following the same business in the same town with you.

RALPH R. LAXTON.

Y 18. Is it good policy to rather encourage installation of a very limited amount of gas in electrically-lighted stores, churches, etc., giving consumer a chance in event of failure of part or all lights at a critical time?

It is not good policy to encourage installations of gas to be used in event of failure of current, as this would indicate the possibility of such failure, and reliability of service is one of the prime requisites for securing business. It might be policy to encourage the use of gas in factories where the lighting load is strictly peak business and is not profitable unless a minimum bill is required. This usually makes the cost prohibitive during the summer months, and unless a minimum is required this business is not profitable. B. J. DENMAN.

Yes, but do it in such a way as not to point out the reasons, unless necessary. It's a good plan to suggest a combination fixture or bracket at a certain place as being more convenient or artistic in effect. There are a great many ways of doing it.

W. W. FULLER.

Yes. Have seen the time when I would have been more than gratified to know that customers had gas.

RALPH R. LAXTON.

Yes. P. L. UTLEY.

Y 19. How can a company protect itself from loss in case of the death or failure of the free-sign customer?

Can not protect yourselves absolutely in all cases, and would be necessary to make your average high enough to figure on certain amount of loss in such case. GEO. N. TIDD.

Use universal letter-changeable signs.
DUDLEY FARRAND.

Y 20. What is the best method of paying solicitors?

We have employed solicitors on a combined salary and commission basis. They would get customers, but promise them more than they should. Often the solicitor left town (we can not employ one the year around) and we would get into trouble by not being able to comply with the solicitor's promises. We now allow a commission on the first four months' bills (maximum total commission paid $3.00) of every new customer who is secured by our bookkeeper, superintendent or electrician. This works well in our town (6000 inhabitants). We get the customer, and our employees increase their wages. They do not promise too much, because if they do so, the customer will probably quit being a customer and the employee will lose part of his commission. Furthermore, the people have more confidence in the statements of our regular employees than those of a temporary solicitor. Our employees, after practically convincing a prospective customer, turn them over to the manager, who closes the deal.
LUDWIG KEMPER.

A stated salary, and in some cases commission on total sales; especially small appliances. JAMES R. SHURTZ.

Pay solicitors on the basis of net increase in revenue secured.
R. N. KIMBALL.

By both a commission and salary. P. L. UTLEY.

The policy of this company is to employ solicitors on a salary and commission basis. We pay a nominal weekly salary with incidental expenses, and allow a commission of two per cent per 16-cp lamp in excess of 750 16-cp equivalents obtained per month for the months of March, April, May, June, September, October, November and December, and 500 16-cp for the remaining four months. This method of employing solicitors has been very satisfactory, the commission acting as an incentive to the performance of extra work, following up, and willingness to keep appointments after business hours.

The Brooklyn Edison, E. W. Phillips.

After experience with several plants, I am satisfied that the best method of paying an average solicitor is a combination of salary and commission bonus according to results secured. The proper control over the time and itinerary of the solicitor can not be secured except by salary and the best services of even the most conscientious men are likely to be intensified by the inducement of a bonus for results. The method of determining bonus and the amount of same will vary greatly according to local conditions, but the principle will hold good in any territory.

The Brooklyn Edison, W. W. Freeman.

Y 21. Can a display department be made to pay by adding a percentage to articles sold?

A display department should be run for the purpose of creating new business. A small percentage should be added to cover a percentage of the expense. The object of the display department should be to get business and not to make a profit.

James R. Shurtz.

We think a display department pays, even if the percentage is not added on the article sold.

United Elec. Lt. Co.

Yes. P. L. Utley.

Y 22. Where can complete data be obtained on special appliances which can be used on lighting circuits?

Join the National Electric Light Association, attend conventions, and read all advertising matter. DUDLEY FARRAND.

Y 23. Is free wiring, where necessary to secure public building lighting, warranted as an advertisement when the company does not do any wiring?

It depends entirely on how much the lighting of public buildings is worth to the company, either in net profit or as a matter of policy. DUDLEY FARRAND.

Y 24. Does it pay a lighting company to do interior wiring where there are no competing electrical contractors?

Yes; but contractors are good new-business getters, they should be looked upon as a help rather than a burden. Get a few competent contractors in your town; you want to sell current, not profitable wiring. W. W. FULLER.

As a proposition by itself it does not pay, but in small towns it seems necessary to do it in order to accommodate customers and to be able to get and handle new business more promptly.
H. D. LARRABEE.

We do practically all the wiring in our town, there being no competition by contractors. We make a small profit and the scheme works satisfactorily. LUDWIG KEMPER.

In a town of about 3000 we have been compelled to do our own wiring and selling of fixtures. We find that unfavorable public sentiment is constantly created by this combination. People are likely to complain of high light bills with charges of robbery against us as contractors. We do not like to do the wiring and would gladly turn it over to others, whom we would aid. This we think would be the better policy and benefit our relations with the public. FRANK BECKWITH.

In cities where wiring contractors have exorbitant prices the company should foster competition by establishing a competitor in wiring business. This will have a tendency to bring contractors down to a fair remuneration. JAMES R. SHURTZ.

Only as a factor for increasing the load, not as a paying business. A. O. FRETZ.

Certainly; otherwise increase of business would be very much limited. W. H. GARDINER, JR.

It certainly would; but if more than one competing electrical contractor, it would not. F. W. BULLOCK.

Yes, even at cost. RALPH R. LAXTON.

Yes.
H. E. RYDER.
R. N. KIMBALL.
P. S. YOUNG.

Y 25. How far should a company go in assisting contractors?

Company should assist contractors in all reasonable ways but great care should be used to avoid unjust discrimination. Preference should only be given for the best work and not for the lowest price. DUDLEY FARRAND.

Y 26. Should lighting companies sell motors or fans in towns where by so doing they antagonize electrical contractors?

In a broad sense, the question of whether or not a central station should enter the trading business by selling motors, fans and other apparatus, is one that must be decided by the local conditions.

If the town is of sufficient size to enable contractors to work up a satisfactory business and invest enough capital to carry adequate stocks, the central station will probably find it unnecessary to enter the trading business and will be likely to procure best results by working with the contractors. Where the town is too small to support electrical contractors with sufficient capital to carry an adequate stock, the central station will probably find it necessary to enter the trading business to a greater or less extent and even in some places large enough to support contractors it may be necessary for the central station to canvass actively for the installation of certain apparatus, owing to apathy of the contractors or to the fact that the contractors may be too busy on construction work, which is ordinarily more profitable to them than is the sale of apparatus, particularly in small units.

Under no circumstances should the lighting company antagonize the contractors. In fact, the interests of the lighting company and the contractors are mutually interdependent, and by the use of proper tact and diplomacy it should be possible for the central station to work as far as necessary in developing its own business without antagonizing the contractors, who can, in many ways, assist the central station.

The details of arrangements between the central station and contractors require to be worked out in accordance with the local conditions present in each place. No general rules can be laid down that will apply. T. M. MESTON.

Should the prices and manner of introducing them by contractors have a tendency to cause your losing the business in the way of current sales, I would say yes, by all means.

J. H. ENRIGHT.

Yes; gas companies found that they had to sell appliances to increase business. We are not ready to turn our new-business future into any contractor's hands. R. N. KIMBALL.

I think that an electric light company should do anything it can in order to promote the sale of current, and if by selling motors or fans it can sell more current, but must antagonize electrical contractors, I should say antagonize them.

F. C. S., MALDEN ELECTRIC CO.

Lighting companies should sell motors and fans through their display department. By taking this business on gradually, it should not antagonize an electric contractor.

JAMES R. SHURTZ.

Not as a rule. When for any special reason it is desirable to make a sale, contractors should be allowed to compete or to sell the apparatus through the lighting company.

RALPH R. LAXTON.

No. F. ELLWOOD SMITH.

Y 27. If a lighting company sells fans and motors, should the price be kept up so that contractors can compete?

Yes; provided contractors sell at a legitimate profit. Lighting companies should fix the price and likewise the profit on all portable appliances, thereby protecting the company's interest as well as the consumer. W. W. FULLER.

There would seem to be no good reason for a central station's selling fans and motors to the consumer at prices that would not allow the contractor a fair margin of profit. If a customer wants a fan motor or a motor of any kind, a difference of twenty per cent in the retail price will not stop the sale.

The great trouble with central stations and electrical dealers is that they do not procure a satisfactory profit, and prices to the consumer on almost all kinds of electrical apparatus are lower than they should be. It is no common thing for electrical apparatus to be sold to the consumer at ten per cent above the manufacturer's selling price to the electrical dealer or central station. Even in such old established and staple lines as clothing and hats the difference between the manufacturer's price and retail price to the consumer will average 25 to 50 per cent. All classes of electrical people selling at retail places too much reliance on price and not enough on salesmanship and arguments of quality to procure the order.

In our judgment, there is no valid reason for a central station's selling any electrical apparatus at retail at prices that will not provide a fair retailers' profit to the electrical dealer. If a central station will pay more attention to salesmanship and less attention to cut prices, it will sell just as much apparatus, and if it is in the trading business it will have that much more net income.

In order to make a sale to a consumer the first thing to do is to convince him that he wants the particular article that is offered. After he is convinced on that point, the question of price is entirely secondary, and if both central stations and contractors would not be so prone to cut prices to the consumer, but would stand out for a healthy and legitimate profit, the entire commercial aspect of the electrical trade would be much benefited. T. M. MESTON.

The price of fans and motors is better determined by the location. In most cases the contractor will try to sell an inferior appliance and in view of this the company should sell the best on a very small margin of profit. JAMES R. SHURTZ.

See answer to Y 26. RALPH R. LAXTON.

To a reasonable extent, yes. J. H. ENRIGHT.

Yes. J. J. CAGNEY.
F. ELLWOOD SMITH.

No. F. C. S., MALDEN ELECTRIC CO.

Y 28. Does it pay a lighting company to sell portables and fixtures?

Yes. A portable lamp uses more current than any other lamp in the house. We often see people reading with a kerosene lamp and using electric light to go to bed by.
R. N. KIMBALL.

It would pay a company to sell portables and fixtures when it is difficult for the consumer to secure these articles through local dealers. JAMES R. SHURTZ.

Not unless the company does wiring. Then selling fixtures at cost it can wire places that otherwise it would undoubtedly be unable to get. This tends to sell more current.
F. C. S., MALDEN ELECTRIC CO.

We sell portables and fixtures at a small margin. We do not carry stock, but sell from catalogue. This works all right.
LUDWIG KEMPER.

Same as for Y 24; merely as an accommodation to our customers. H. D. LARRABEE.

We deem it advisable. THE PHILADELPHIA ELECTRIC CO.
P. S. YOUNG.

Y 29. What is a fair average number of meter readings per man per day?

Our men average 249 readings per day, this including the business and residence districts and the reading of gas and electric meters by the same man. FRANK W. FRUEAUFF.

The number of meter readings one man can take per day depends on whether meters are scattered over a large area or bunched. Taking an average-sized city, under average conditions, should say that a good man could make 200 readings.
W. W. FULLER.

One hundred and seventy-five.
W. R. B., N. Y. ED. CO.

One hundred and twenty-five. J. J. GAFFNEY.

Laid out in routes, 100 meters.
F. C. S., MALDEN ELECTRIC CO.

This depends altogether on local conditions—as to how large an area a certain number of meters cover. In resident districts where meters are nearly all in attics, about 50 meters per day; in business places, where meters are wired, as they should be, not over seven feet from the floor, about 100 meters per day.

F. W. BULLOCK.

Y 30. Who has charge of the meter readings? Do your meter readers report to the accounting department, to the office, to the meter department, or to the superintendent of distribution?

Our meters are read by experienced inspectors. Inspectors report to office of superintendent of light and power department on all regular inspection work. All meter readings, however, are checked by the chief inspector and are then turned into the accounting department, where an experienced clerk makes up the bills; if any unusual irregularities are noticed the clerk holds the bills for further investigation. W. W. FULLER.

The meter reading is in charge of the superintendent of distribution, who gives out the route books and has them returned to him, this work being done as nearly as possible in connection with the accounting department. FRANK W. FRUEAUFF.

The meter readers are under the superintendent of distribution, but report to the accounting department for instructions.

J. J. GAFFNEY.

A department designated "billing department," which handles all meter readings, consumers' bills, and so forth.

J. J. CAGNEY.

The matter of reading meters is purely an accounting matter and should be entirely in charge of the accounting office.

JAMES R. SHURTZ.

(Concurrent opinions expressed by F. C. S., MALDEN ELECTRIC CO., W. R. B., N. Y. ED. CO.)

The statement is made that the reading of meters is purely an accounting matter and should be entirely in charge of the accounting department.

On the face of it this statement seems to be a plain fact not subject to question or argument, but a common-sense investigation of the situation will reveal conditions which might even convince an accountant that the stand taken by him is subject to successful assault.

The object of an electric light company is to sell light, and to do this successfully in competition with other illumination having the advantage of lower cost, it must take full advantage of the possibility of relieving the customer of absolutely everything else in connection with his lighting except the payment of his bill, correctly rendered.

Unfortunately, the manufacture of electric meters has resulted in a variety of instruments involving a more or less confusing agglomeration of dials, and the exigencies of the operating and purchasing departments have prevented the uniform use of a single make in the case of almost every company. It is self-evident that to avoid errors the advantage of experienced meter readers is of much greater importance than it is in the reading of gas meters, for instance.

The most experienced men available would be the men who not only know the face of the meter but its bowels as well. The percentage of errors will invariably be smaller if the meters are read by the men who set, test, change, and repair them, than if by men whose familiarity with the business must at best depend upon a necessarily limited course of instruction in the meter department. The former are much more likely to remain with the company for a long period and consequently become more expert than men employed merely as readers.

But the main point is that the station men will be able to detect, and do detect while reading, any meter that is grossly out of order or stopped altogether; and not only this, they will also note conditions in the fuses, wiring, *et cætera,* which might lead to trouble, and will take the necessary steps to prevent it.

They will note changes in connected load, manner of use of connected load, or anything else that has a bearing on consumption and the size of bill.

This practically amounts to a regular monthly inspection and helps wonderfully in the explanation of unusual differences in bills and the consequent settlement of complaints.

It would further seem that reading meters from the office would necessarily involve increased expense, as it is highly advantageous for the correctness of comparative monthly statements to have meters read in the shortest possible time and as near the end of the calendar month as it can be done, so as to prevent gross distortion of the relation between current manufactured and current sold.

It would therefore be necessary to employ a force of men, busy to advantage only during about one-third of the time, in case meters are read from the office, while if they are read by the station force this objection at once disappears on account of other work of the meter department.

However, I hardly think it possible to make a hard and fast uniform rule for meter reading for a company embracing in its jurisdiction all kinds of territory, from districts of almost metropolitan aspect to sparsely settled rural communities. EDITOR.

Meter readers report to the accounting department.
G. H. CUSHMAN.

Have generally had meter readings left with superintendent and figures checked by him. RALPH R. LAXTON.

Y 31. In a city using single-phase alternating current for lighting, is multi-phase alternating current or 500-volt direct current preferable for power circuit within one mile of plant?

Five hundred-volt direct-current would probably be more satisfactory, but it will not permit of the same station flexibility as would the multiphase alternating-current. W. W. FULLER.

Multiphase alternating-current by all means, on account of the fact that lighting and power can be furnished from one, whereas with 500-volt direct-current it would be necessary to have two kinds of machines in the plant. M. C. TURPIN.

Multiphase service for power purposes is much to be preferred. L. L. ELDEN.
F. C. S., MALDEN ELECTRIC CO.

Five hundred-volt direct current is the best.

G. H. CUSHMAN.

Unless the amount of power is considerable, the 500-volt direct current will have a higher all-day efficiency with varying load and will also be found more flexible. For loads above 100 to 150 kilowatts, anything else than three-phase alternating-current is hardly advisable except under peculiar conditions.

RALPH R. LAXTON.

Y 32. Has experience with single-phase motors in sizes up to 25 horse-power shown them to be as generally satisfactory as multiphase motors?

Single-phase motors up to 25-hp have been generally satisfactory so far as mechanical construction is concerned, but motors of this type have not been satisfactory when operating conditions are considered, they proving to be very disturbing factors when operated from mains supplying lighting service.

L. L. ELDEN.

A single-phase motor with good starting torque is difficult to construct and consequently expensive. Experience has shown this motor to be far from that stage of perfection at which the multiphase motor has arrived. It should never be used where a multiphase motor can be substituted without much additional expense of wiring.

"VOLAMPWAT."

Single-phase motors of the induction or synchronous type are not so satisfactory as polyphase motors of this type. There are some conditions under which a single-phase commutating motor is preferable to polyphase motors of other types.

F. C. CLARK.

My experience shows them to be inferior as motors, in any size in which polyphase apparatus is to be had.

RALPH R. LAXTON.

No.

F. C. S., MALDEN ELECTRIC CO.

Y 33. What amount of investment per kilowatt is a central station warranted in making in translating devices, such as lamps?

Any amount by which the sale of current for the device will yield interest and depreciation and a fair profit on current sold.

HERBERT McNULTA.

Y 34. (a) What practices or systems are in vogue in plants not large enough to afford the expense of a night inspector or trouble man? (b) Do you believe in offering extra compensation to any one employee to take care of complaints that come in after 5.30 p. m.?

Our plant is in a town of 10,000 inhabitants and we could not afford a night inspector. However, our contract for city arc lights requires that they be inspected, and every light seen burning between 9 p. m. and 10 p. m. We have our arc-light man go to work at 10 a. m. and work until 10 p. m., at what he would get if he worked from 7 a. m.; *i. e.*, $60. He is also our lineman. The calls on lines for "trouble" do not average more than three a week and the trouble is generally due to the customer's carelessness, such as failing to turn his switch.

W. H. THOMSON, JR.

We have four men, each of whom takes one week in each four as trouble man. He is on from 6.30 to 8.30 p. m.

A. PETERS.

(a) If the service does not warrant expense for all-night trouble man, let him come on in the afternoon and look after trouble from beginning of peak to midnight. If this is not warranted, chances must be taken. (b) If he puts in extra hours, yes, but at regular rate. HERBERT McNULTA.

I have observed, to a small extent, the practice of letting employees take daily turn at night of one and one-half to two hours at office, going home an hour and a half or two hours before quitting time, to compensate for the extra time..

F. M. VANDER VOORT.

Have had good results from having telephone connection with residence of one or more competent trouble men, having customers, including city police, advised of this arrangement and having men leave telephone or other address at which they can be found if absent from home. Careful selection of men and liberal treatment as regards hours of work, short leaves of absence, *et cætera,* will insure co-operation and a personal pride on part of the men in the character of service rendered by the company, and this means prompt attention to troubles.

Ralph R. Laxton.

Y 35. What analytical method is employed by the managements of large substation systems in fixing scales of wages of substation operators? I refer to those systems which include a great number of substations, each of a different grade, both in regard to extent of development and importance in the territory; also including operators of various grades in each substation.

Y 36. On what results obtained by solicitors should commission be based?

Y 37. (a) What is being done by the various corporations operating electric, or compound gas and electric, properties toward a concise and uniform set of rules and instructions to station, distribution and other employees? Into how much detail do you consider it necessary to go in instructions of this kind? (b) What bearing on damage suit would the prior enforcement of such a set of rules and instructions have? (c) Do you find that the enforcement of such a set of rules and instructions tends to make employees more careful and to get a better class of work from them?

Y 38. What has been the experience of the management of large substation systems concerning the advisability of encouraging the organization of social or other clubs among their substation employees?

Establish an organization of employees and time and place to meet. Alternate these with talks on subjects of general interest and entertainment features. E. A. M., N. Y. Ed. Co.

Y 39. Do the majority of electric light companies carry accident insurance to cover both the public and employees?

We carry no accident insurance to either public or employees in our lighting department, having found that the results secured from the insurance do not warrant the expense.

T. H. T. & L. Co.

We carry public and employees' liability insurance.

United Electric Lt. Co.
Birmingham Ry. Lt. and Pr. Co.
F. D. Sampson.

Y 40. Six parties are usually interested in having the Underwriters' certificate covering the electric equipment of a building properly issued—the underwriters, owner, tenant, wiring contractor, fixture contractor and the lighting company. State what duties, in your opinion, each party should take upon itself in securing the certificate. State actual present usage in connection with matter.

As a natural business proposition the Underwriters' interest is only to know that the inspection of wiring has been duly made and the certificate issued or that their policies are canceled. The owner and tenant of property which might be damaged by fire (who are the holders of the insurance policies) are the parties particularly interested in knowing that the wiring is in perfect condition, so that they should look to it that the inspection has been properly made and the certificate issued. The lighting company is also interested and should see to it that the inspection has been properly made, because it can not afford to risk the charge of carelessness which may result from fires produced by electric wires. The contractors may be required by their contract to pay for the inspection, but the owners of property that might be jeopardized by improper wiring is the proper party to see that the inspection is properly made. Where the owners do not look after this, the electric light company can advantageously take it upon itself to see that inspections are properly made or may even make inspections for itself before connecting up the service wires.

Dugald C. Jackson.

The owners, tenants, underwriters and supervising architect appear to be interested in the order named; contractors only to the extent of getting their pay, which is frequently not contingent upon the issuance of a certificate of inspection.

The lighting company may have a form of contract in which its responsibility for installation of interior wires is specifically limited to such wiring as is done by it as a contractor; and it would not ordinarily wish to take the risk of becoming involved in controversies between contractors and owners.

Cities should have ordinances providing that cut-ins shall be made by lighting companies only after proper certificates have been issued. RALPH R. LAXTON.

Y 41. What can be done to meet isolated-plant competition?

Isolated plants can not compete with central stations if the latter are thoroughly modernized. F. D. SAMPSON.

In order to meet the competition of isolated plants, or, in other words, to prevent the installation of isolated plants, it is necessary to make a careful analysis of each individual case and this analysis should be presented to the right parties.

There are five distinct classes of people, one or more of which take up the question of light and power in a building.

First—The owners themselves.

Second—The tenants of the building.

Third—The agents of the building.

Fourth—The architect.

Fifth—The engineer or consulting engineer. The interests of these five classes should be classified, as follows:

First—The owner, whose interest it is to secure the most satisfactory and economical operation of the building and whose especial point of view is that of the investor who wishes a certain net return.

Second—The tenant or tenants, to whom the question is purely one involving the comparative economy of the central station versus isolated-plant service and who as a rule are anxious to be relieved of the responsibility and annoyance of operating an isolated plant, provided the service can be secured from the station at approximately the same cost.

Third—The agent of the building, who is primarily a real estate man, whose business is the buying and selling of real estate and the handling of properties in such a manner as to secure the best net economy from any given property.

Fourth—The architect, whose business is to plan and superintend the construction of buildings and to whom the installation of an electric-light plant, with all its accompanying detail, is a matter of considerable trouble and annoyance. The additional income the architect receives from his percentage of the cost of the plant hardly compensates him for the extra time and trouble required, as his time could be more profitably used in other directions.

Fifth—The engineer, or consulting engineer, who is interested directly in the installation of a plant; the engineer, since it is his business to operate plants; the consulting engineer, since it is his business to plan the installation of plants.

Very frequently the reason that an isolated plant is installed is because the solicitor from the central station does not have a proper comprehension of the different relations which these different classes have to the building in question. Frequently the solicitor will spend days of valuable time arguing the question of plant versus central-station service with a consulting engineer whose mind had already been made up and whose only motive in taking the matter up with the central-station agent is to secure data from which to present his case to the owner or the architect.

On the other hand, other buildings have been lost to the central station simply because the solicitor assumes that the attitude of the architect is a hostile one and that he is not to secure a fair hearing. The experience of the writer is that the best architects are honestly desirous of securing what is most economical, all things considered, for their clients, and if they advocate the installation of an isolated plant, it is simply because they are influenced in their opinion by the representations made to them by engineers and electrical contractors who are in favor of the plant. It should be borne in mind by the solicitor for the central station that while he may present arguments in favor of central-station service, there are many other interests whose representatives are going daily into the architect's office and are urging the reverse proposition. Every dealer in electrical supplies, every consulting engineer, every engine and dynamo contractor is urging on the architect the advantage of an independent isolated-plant and as a result it is hardly to be expected that the dictum of the central-station solicitor be accepted without question. But there are a great many central-station solicitors who, while they will spend a great deal of time patiently explaining the matter to the architect, entirely neglect the consideration of the owner or agent of the building, and this very frequently proves to be a costly oversight. It is a remarkable fact that men of large means and great property interests, no matter how much their time is employed in other matters, are always interested in this question of isolated-plant versus central-station service, and in the majority of cases are not only willing, but glad, to make personal investigation of the comparative merits of the two opposing lines of argument. The most progressive real-estate agents in our large cities realize that this is a vital question for them to settle in the administration of the large business blocks which they handle, and a proper understanding of the merits of the central-station proposition as applied to one particular building will often not only bring that individual building on to the central-station service, but will be the means of securing a large amount of additional business controlled by the same agent.

Very often it is necessary not only to convince the owner or agent of the building of the advisability of omitting the isolated plant, but it may also be necessary to see the tenants of the building. An owner is sometimes forced by his tenant to install an isolated plant in order to make a lease of a building, owing to a mistaken idea of the tenant that there is great economy in operating a plant. In view of the above it will be seen that it is extremely important for central-station managers to become thoroughly well-informed concerning all the transactions connected with the financing and leasing of a large building, in order that the benefits of central-station service can be presented to the right parties and at the right time. Careful attention to these points and the intrusting of the discussion only to the most competent solicitors will gradually overcome the prejudices of the customer and eventually win for the central station the control of the situation.

S. MORGAN BUSHNELL.

The average isolated-plant superintendent or engineer does not know what it is costing him *per kilowatt-hour* to generate electricity. In the majority of cases he will either multiply the kilowatt capacity of the dynamo by about the number of hours run, or will multiply the high-average amperes by the voltage he is supposed to carry, to obtain the kilowatts, and then multiply the number of hours run to obtain the kilowatt-hours generated. It is human nature for the engineer to make the readings as high as possible.

To avoid this personal equation it is desirable to connect one or more wattmeters on the plant, checking up the coal and water records weekly. If steam is used for other purposes, two or three test runs of the engine should be made to determine the water rate, or the condensed water from the other apparatus be measured. Having the true cost per kilowatt-hour, the agent can show the advantage of central-station service.

THE BROOKLYN EDISON, C. A. GRAVES.

If your service is good and production on basis enabling you to compete in price, take advantage of the growing demand for economy in building-space, elimination of smoke, dirt, and noise nuisances, watch for depreciation and hidden leaks in isolated plants, and you should at least be able to prevent the duplication of many isolated installations now overloaded or worn out, and also use them as object lessons to prevent new installations of the same class.

RALPH R. LAXTON.

Intelligent work by solicitors.

BIRMINGHAM RAILWAY, LIGHT AND POWER CO.

Y 42. In a city where there are a great many transient customers, what can be done to prevent the customers from moving between meter readings without notifying the company, in this way beating their bills for a portion of a month?

Secure deposit to cover estimated month's bill, read meters and collect bills weekly, or secure deposit to cover estimated week's bill, reading and collecting weekly.

T. H. T. & L. Co.

Require a deposit in advance, larger than the estimated consumption for a month, or a guarantee by some reliable party.
HERBERT MCNULTA.

If you will get a sufficient deposit from a customer when connecting him, he will usually notify the company of his removal and collect any balance due him. W. P. SCHWABE.

Deposits, or estimated payments in advance.
BIRMINGHAM RY., LT. AND PR. CO.
A. PETERS.

Put them on prepayment meters. C. K. MUNNS.

If the customers are known to be transient, prepayment meters would solve the problem. Otherwise the deposit system for those not having established credit seems the only way.
RALPH R. LAXTON.

I have found that requiring a guarantee deposit from transient customers before turning on the current, and making prompt collections, has been of great help.
THE BROOKLYN EDISON, P. R. ATKINSON.

Y 43. In a large city divided into districts, is it advisable to have complaints adjusted by each district office, or should they be handled from the main office, and why?

Complaints should all be referred to the general office, especially when the bills and records are all taken care of at that office, as full information regarding any charge or any records can be readily obtained without delay. It may be well to have the city divided into districts, and an outside inspector cover these districts when calling upon customers. He should, however, report to the general office and all cases should be brought to a focus at this point. A smaller force is required to handle complaints in this manner, and we believe that all records are more easily accessible if kept at one point.
W. R. B., N. Y. ED. CO.

To guard against discrimination or charges of discrimination, it seems that central claim or complaint departments—not a "side-tracking" department, however—should be established.

RALPH R. LAXTON.

Y 44. How do companies average bills when the registration of meter is high or low?

Averaging correct meter registrations for the purpose of equalizing bills from month to month leads to a reputation for dishonesty. It *is* dishonest. Better stand the kicks than be caught at it. If meter has stopped, average the consumption before and after and be liberal with the consumer. If the meter is fast, discount the bill liberally beyond the amount called for by meter test. HERBERT MCNULTA.

I don't think it is good policy to average bills; it makes a wrong impression on the consumer. If a bill is too high or too low, verify the index by a second reading and, if found correct, render the bill. W. P. SCHWABE.

Test the suspected meter, and increase or decrease bill by the percentage meter is slow or fast. A. PETERS.

Y 45. Should the contracting or the auditing department decide upon the credit of a prospective customer?

The contracting or sales department on advice of auditor.

BIRMINGHAM RY., LT. AND PR. CO.

The accounting or credit department of a company should decide upon the credit of a prospective customer rather than the contract department. The contract agent is likely to be influenced by his desire for business and it is well to have a conservative check exercised by some one else. GEO. E. BURNS.

The contracting department should not be burdened with duties calculated to upset pleasant relations with the public.

This department is of more value to the company, even in credit matters, when it can act as a sort of mediator between the credit department and the customer. RALPH R. LAXTON.

I believe that the treasurer (or his collection bureau), who is responsible for collections, should have the privilege of passing upon the credit of prospective customers.

THE BROOKLYN EDISON, P. R. ATKINSON.

Prospective customers' credit should be passed upon first by the contracting and finally by the auditing department.

P. S. YOUNG.

Y 46. Up to what distance would it be more profitable to locate a plant at the mines than at the centre of distribution? Maximum to be distributed, 15,000 kilowatts; load factor, 30 per cent; freight on coal, half a cent per ton per mile; 4.5 pounds of coal per kilowatt-hour.

The item of real estate charges enters very largely into this question, as well as that of relation of market value of power to cost of production; or, in other words, the amount of line loss you can stand. Assuming 5-per cent line loss and duplicate lines for 4500 kilowatts, the limit would apparently not exceed 20 miles with voltage even as high as 60,000. With 1000 volts per mile, 5-per cent loss and 85-per cent power factor, the cost of copper would approximate $12 per kilowatt for each three-phase line. This cost would decrease as square of increase in voltage up to the point of mechanical limitation, but the increased voltage would demand more expensive line construction and apparatus. The answer to this question would hardly be the same for any two individual cases. RALPH R. LAXTON.

Z—LEGAL

Z 1. Under what conditions may a right-of-way for poles, lines and wires be made permanent, unless a consideration is made to especially cover its permanency?

The granting of the right by the proprietor to place poles on his land, for any consideration whatsoever, would constitute a servitude upon the property, which would be permanent without registration unless the terms of such grant specifically restricted the duration of such right. J. J. CAGNEY.

A right-of-way for pole line is usually permanent on streets of cities and municipalities where charter rights are perpetual and there are no limitations in the franchise of the company. Private rights-of-way can only be made permanent either by or through the exercise of the right of eminent domain, when existing, and payment of consequent damages, or by special contract with the owner of the land. ERNEST H. DAVIS.

Deed for right-of-way would probably be strictly construed, and if it is to be for permanent occupancy it should contain words of inheritance such as "heirs and assigns"—or "successors and assigns" if made to a corporation—and should recite a consideration. RALPH R. LAXTON.

In New Jersey the right to erect poles on the public highways is given by the legislature to electric lighting companies for the purpose of their business, provided the consent in writing of the abutting property be obtained. When such consent is given without limitation or restriction and the pole is erected in accordance therewith, the right to maintain it permanently is unquestionable. L. D. H. GILMOUR.

Z 2. We are changing from 220-volt direct-current 3-wire distribution to 2200-volt alternating current. The local telephone company raises objection on account of danger. Has this objection any valid legal basis?

No telephone company can object to the use of 2200-volt alternating-current, provided the wires are separated a reasonable distance, which in the case of the Western Union Telegraph Company vs. Electric Company, reported in forty-six Missouri appeal reports, page 120, three Am. Elec. Cases 425, was decided to be three feet. A distance of five feet would constitute an absolute defense against any claim by a telephone company.

ERNEST H. DAVIS.

As the great majority of distribution systems are carrying at least 2200 volts, it would seem as though the objection by the telephone company could be easily overcome.

F. ELLWOOD SMITH.

Not unless the wires are so close as to be considered an unlawful interference. See also answer to question Z 3.

J. J. CAGNEY.

None whatever, unless it is based upon an ordinance prohibiting the use of the proposed voltage, or upon some restriction in your franchise. Ample evidence may be had to show that this change, if properly made, will not injure a well-constructed telephone system. RALPH R. LAXTON.

None at all. The telephone company has no paramount or exclusive right. L. D. H. GILMOUR.

Z 3. Is there a state law, written or implied, requiring 2300-volt lines to be placed at certain distances from telephone, or other wires? If so, at what distance?

The usual distance when fixed by private agreement is not less than five feet. ERNEST H. DAVIS.

In Canada, the rule has been laid down that such wires should be at least three feet apart. J. J. CAGNEY.

Not in Nevada. F. O. BROILI.

Don't think there is a specific law in any state covering this distance. In event of damage from accidental contact of wires, either or both companies might be called upon to show "due diligence" in the installation of lines, and this would be a question of fact for the jury to decide.

Municipal ordinance may, however, govern such points, and would have the validity of a state law. RALPH R. LAXTON.

Not in New Jersey. L. D. H. GILMOUR.

Z 4. Assuming an underground conduit system has been installed by an electric light company in compliance with franchise and municipal ordinance, should the company or the city bear the expense of moving, altering or repairing the conduit system in case such becomes necessary to accommodate new or additional water mains, sewers, drains, etc., belonging to and installed by the city? Can you give records of legal decisions bearing on this or similar cases?

In the permission given us by the city for construction of underground conduits system, it is stated that we must remove our conduits if it becomes necessary for the city to lay a sewer or water pipe in our location. UNITED ELECTRIC LT. CO.

If the conduits were installed in compliance with the company's franchise or charter rights, and with the consent of the municipal authorities, any charges required subsequently by reason of new construction installed by the city would have to be made at the expense of the latter. For record of decisions, consult volumes of American electrical cases. J. J. CAGNEY.

It is likely, where it is absolutely necessary for public improvements, that the conduits of a private company be moved, that such expense should be borne by the private company. Generally, convenience or the question of cost alone will not transfer the expense from the municipality to the private company. See Western Union Telegraph Company vs. Syracuse (N. Y. Sup. Ct.)—53 N. Y. Supp., 690 24 Misc. (N. Y.) 338.
ERNEST H. DAVIS.

As the lighting company acquires no right of property in city streets, the municipality would probably have a legal right to order removal at company's expense unless the franchise contained some provision for such cases. Actual damage to company's property might have to be accounted for by the city. Have no record of judicial decision on this point.

RALPH R. LAXTON.

Z 5. Has the judiciary body of a state the right to fix rates?

Not unless authorized by law or the constitution of the state in question.

ERNEST H. DAVIS.
J. J. CAGNEY.

This power might be vested in a corporation commission, but I do not think it is inherent in the regular courts.

RALPH R. LAXTON.

No.

L. D. H. GILMOUR.

Z 6. Has the legislative body of a state the right to fix rates?

Yes.

ERNEST H. DAVIS.

I think it has for practically all classes of public service and also the right to delegate this power to municipalities so far as it applies to corporations who depend for existence upon a municipal franchise. The legislature of Mississippi has passed a law giving municipalities this right, subject to review by the courts in case the rate so established is deemed unreasonable. I have not yet heard of a case where this authority has been exercised or contested.

RALPH R. LAXTON.

Yes.

L. D. H. GILMOUR.

Z 7. Have municipal authorities any legal standing in making or regulating the rates of public-service corporations in their municipalities?

Not unless authorized to do so by their state legislature or by contract with the public-service corporation involved.

J. J. CAGNEY.
ERNEST H. DAVIS.

If the municipality has the power to grant or refuse permission to a public-service corporation to use the streets, it can in granting such permission limit rates or it may reserve the right to regulate. If such a permission is accepted by the corporation and acted upon, it becomes a contract that is binding upon the corporation in all its terms. In the absence, however, of such a contract or of authority conferred by the legislature, a municipality has no power to regulate rates. L. D. H. GILMOUR.

Z 8. Has a public body, judicial or legislative, which has the power of rate making, the right to fix rates on the aggregate or mass—for the whole community—amounts and averages, always, of course, under the Federal restrictions—or must it allow all individual costs in so far as these are individually determinable?

This raises a debatable question, and can only be answered generally. Personally, I believe that the courts will not sustain a very high rate simply because such rate in a few cases may be unprofitable to a private company. On the other hand, it is reasonably clear that an average profitable rate can not be sustained as a legal maximum rate. ERNEST H. DAVIS.

The legislature is supreme, and its enactments can only be set aside when contrary to the federal constitution.
J. J. CAGNEY.

Rates must be uniform. There is not, and can not be, a Federal restriction except as regards interstate commerce, or where a state attempts to pass a law impairing the obligation of a contract. RALPH R. LAXTON.

These questions are now the subject of extensive litigation and I am not aware that a decision has been rendered.
L. D. H. GILMOUR.

Z 9. Assuming that local charges must be individually differentiated in proportion to individual costs, in so far as these are determinable, and that individual costs are individually de-

terminable, say to the extent of 60 per cent of the total legitimate costs, how does the law say that the remaining 40 per cent of legitimate costs, which are assumed to be individually indeterminable, shall be assessed?

The recent report of Messrs. Arnold and Carroll, representing the Chicago Council Committee on oil, gas and electric light, may throw light on this subject. See *Electrical World* of March 31, 1906. ERNEST H. DAVIS.

See answer to question Z 8. J. J. CAGNEY.

See answer to Z 8. L. D. H. GILMOUR.

Z 10. Within what Federal restrictions must state authorities act in rate making or regulation?

The restriction is that no person or company can be deprived of property without due process of law, and it has been construed that confiscation of property through inadequate rate charges imposed by law is within the constitutional prohibition.
ERNEST H. DAVIS.

See answer to Z 8. RALPH R. LAXTON.

There is no Federal control limiting the authority of states to regulate corporations created by the states and unless such corporations engage in interstate commerce they are not subject to Federal control. L. D. H. GILMOUR.

Z 11. Has the legality of the fixed minimum charge been passed upon by the courts? What was the outcome, and where can the records of the case or cases be found?

Under the New York laws by which an electric light company is required upon application to make connections with and furnish light to any building, but which contains no provision limiting rate which may be charged by the company, it is held that such a company may require, as a precedent, an agreement to pay a reasonable minimum charge,—Gould vs. Electric Light Company, 60 N. Y. St., Repr. 559; in which case $1.50 a month was held to be a reasonable minimum charge where it appears that the company was obliged to expend $20 for each additional lamp attached to its circuit. ERNEST H. DAVIS.

If there have been any decisions they will no doubt be found fully reported in volumes of American electrical cases.
J. J. CAGNEY.

Not directly, I think. The rule is that lighting companies may make reasonable and uniform rules binding on all customers for the same class of service. A rule for a minimum must be uniform in its application. L. D. H. GILMOUR.

Z 12. A damage suit has been brought against a company where a banker went into a bank, took hold of an electric light bulb with one hand and the safe door with the other and was killed. Have you any record of any case where a person was killed with 110 volts?

Such an accident is reported to have occurred in the shops of a large corporation in the city of Montreal.
J. J. CAGNEY.

Not with 110 volts. It is doubtful if any one could be killed under conditions noted. Was it an alternating-current circuit? Was man's hand burned by arcing in any way? If so, sure signs that high-voltage wire came in contact with secondary or low-voltage wires in some way, and neutral of system was not grounded. F. O. BROILI.

Have heard of a man being killed by touching 110-volt socket, investigation showing that the primary was grounded to the secondary of the transformer. Deadly effect of electric current depends to a great extent on the contact made and the condition of health of the person receiving the shock. Several instances are known where persons have received voltage up in the thousands and are still living, while quite a number are known to have been killed on such voltages as are ordinarily handled with impunity. M. C. Turpin.

We do not know of a case where death resulted from a 110-volt shock, and we doubt that a 110-volt shock could kill. W. W. Fuller.

Yes; we have a record of a man killed by shock from 55 volts. L. D. H. Gilmour.

No; but death might have been caused by accidental contact of primary and secondary coincident with ground on another part of the system.

There is record of a decision adverse to the company in case of a death similar to that mentioned in Z 13 where it was proved that primary and secondary lines were crossed.

Don't remember name of case or state, but think it was published in *Street Railway Journal* about eighteen months or two years ago. Ralph R. Laxton.

The banker undoubtedly received the primary voltage of the circuit, the probability being a break-down in transformer between primary and secondary windings. The secondary outside the building not being grounded and there existing another ground, the deceased received the full primary voltage. A. Peters.

Z 13. A company has been sued by the widow of a former customer for $10,000 damages on account of the husband receiving a shock from a combination swinging bracket in the bath-room of his residence, which, in connection with heart disease, caused death. What information can you furnish as to decisions in cases of like nature heretofore tried?

In the case of the Royal Electric Company of Montreal and Heve, 32 Supreme Court of Canada reports, Page 462, the company was condemned under very similar circumstances, but in that case it was proven that primary current had gotten into the premises. J. J. Cagney.

Case of Whitten against Reno Power, Light and Water Company. Whitten took hold of lamp socket and touched water pipe. No evidence of puncture of transformer, and no place could be found where the primary 2200-volt wires were nearer than eighteen inches to the secondary 110-220-volt three-wire system. Neutral of secondary was not grounded. Suit was brought on grounds that if neutral had been grounded, Whitten would not have met his death. Jury awarded $8000 damages with costs. Case tried before Judge Hawley of U. S. Supreme Court, at Carson, Nevada. F. O. BROILI.

Assuming that the shock was of an electrical nature, the question does not suggest enough to pass an opinion upon, because it does not indicate any defect in the bracket or in the wiring on the premises, nor does it show whether the company put in such wiring or bracket and whether the same was so far under its control as to require inspection and make the company liable for any failure therein.

I suppose that one of the important features in the case is the fact that the customer had heart disease, and the question arises whether this condition made him more sensitive to shock and whether, in view of that condition, the company, if liable, can be held for such death.

It was held in Owens vs. Kansas City &c., 4 Amer. & Eng. cases, 590, 95 No. 169, that it is no defense that the injuries received would not have been so great had the passenger been in good health. This case involves injuries to a passenger to whom there was due a very high degree of care, but it seems to me that the principle is about the same, and the verdict was based upon the following request to charge:

"The defendant is responsible for all the ill effects which naturally and necessarily follow the injuries in the condition of health in which plaintiff was at the time, and it is no defense that the injuries may have been aggravated and rendered more difficult to cure by reason of plaintiff's state of health, or that, by reason of latent disease, the injuries were rendered more serious to her than they would have been to a person in robust health."

If the condition which caused the shock in this question was such as to make the company liable, I should say that it would be liable for the death of the party regardless of his condition of health, because if it is the duty of the company to guard against such shocks it must also be the duty of the company to take into consideration the fact that people of all conditions of health will come in contact with its apparatus and all are likewise entitled to be safeguarded from harm or at least to receive notice of the dangers incident to the situation.

Encyclopaedia of Law and Precedure, otherwise known as Cyc. Vol. 15, page 471, on the question of measure of care required by electrical companies says:

"Electrical companies are not insurers of the safety of the public or of those whose occupation is likely to bring them into dangerous contact with their appliances, and hence are not liable for injuries unless guilty of some wrongful act or omission. The measure or degree of care required of electrical companies is variously defined, but it is conceded that the consensus of opinion is that they must exercise that reasonable care consistent with the practical operation of their business which would be observed by reasonably prudent persons under like circumstances, increasing the care with any change in conditions likely to increase the danger and giving due regard to the existing state of science and of the art in question." L. D. H. GILMOUR.

See answer to Z 12. RALPH R. LAXTON.

Z 14. Assuming a broken telephone wire cuts through the insulation (triple-braid, weatherproof, previously in good condition) of an electric light wire carrying a 2200-volt current, and causes the death of a person coming in contact with the telephone wire, is the owner of the electric light wire legally responsible?

The Supreme Court of Michigan, in the action of Stark versus the Muskegon Traction and Lighting Company, has affirmed the decision of the lower court in favor of the defendant. The main points were: (1) Negligence of an electric light company in violating an ordinance requiring wires to be strung twenty-five feet above the ground will not be presumed to have caused or contributed to an injury to a child who came in contact with a loose telephone wire that had been thrown over the wires of the light company. (2) The fact that a child who seized a telephone wire, suspended over a defectively-insulated electric light wire, was not aware of the danger of so doing, is not sufficient of itself to charge the electric light company with responsibility for injury to the child. (3) Electric light wires were suspended only nineteen feet above the ground, whereas the city ordinance required them to be suspended twenty-five feet above the ground. There was also evidence of their defective insulation. Plaintiff, a boy ten years of age, was playing with other children on the ground beneath the wires, when a telephone wire, strung on the same post with the light wires, became broken and was thrown by one of the children over the light wires, where it came in contact with defective insulation.

Plaintiff took hold of the telephone wire in order to experience the shock which another boy had received, and to show his valor, and was injured. Held, that neither the defective insulation nor the distance of the wires from the ground was the proximate cause of the injury to plaintiff, but such injury was the result of his own wrongful interference with the wires.

EBENSBURG LT., HEAT AND PR. CO.

In answer to Z 14 I would refer you to the case of Rowe vs. New York and New Jersey Telephone Company, *et al,* 9 Amer. Neg. Rep. 528, being a decision of the Supreme Court of New Jersey, and the opinion delivered by Mr. Justice Dixon. In this case one of the defendants maintained in a public street a line of wires carrying a harmless current of electricity, and the other defendant maintained in the street, below that line, a transverse line of wires, carrying a dangerous current. There were no guards to prevent one of the upper wires, which fell, from coming in contact with the lower wires, and thus conducting their dangerous current down to the surface of the street. It was held that the absence of such guards would sustain a finding that both defendants had neglected their duty to traverse on the wire.

In the question particular reference is made to the good insulation on the electric wire. I assume that the insulation would be considered as practically no different from the insulation on the electric wire in the Rowe case, which was decided 1901, so that the question as to whether the insulation was a satisfactory precaution was not considered and the question of negligence was decided on the failure to use a guard wire, and the court held that if a guard such as was referred to in the opinion would be a reasonable means of preventing danger likely to arise from the breaking of a telephone wire, it was the duty of the companies to provide the guard or see that it was provided and a failure to do so was negligence.

It was decided in the case of New York and New Jersey Telephone Company vs. Bennett (Court of Errors and Appeals, New Jersey, March Term, 1899) that the question whether the lineman of the telephone company had been reasonably diligent in discovering the fallen wire and in preventing probable injury was properly left to the jury. It was also held in this case, which was a case where a telephone wire dropped over a trolley wire, that the question whether the failure of the trolley company to use guard wires was negligence was a question for the jury.

My answer to the above question, therefore, is that the owner of the electric light wire is legally responsible for injuries received by a traveler on the highway under conditions stated in the question and that the telephone company is likewise negligent, because neither of said companies used a guard wire, which seems to be, so far as the cases are concerned, the most reasonable means to prevent just such an accident as occurred. L. D. H. GILMOUR.

Should say telephone company, on *prima facie* evidence.
RALPH R. LAXTON.

No. The telephone company would be liable, provided there is no joint ownership and both parties occupy the same pole with contract drawn in such a way that it specifies as to which company shall be liable. F. C. S., MALDEN ELECTRIC CO.

It is possible under the circumstances stated for the lighting company to be responsible. ERNEST H. DAVIS.

Z 15. Has liability insurance, either employers' or public, paid the company, or is the amount of losses much less than the premium?

We carry our own employees' insurance, except for those engaged on hazardous construction work; the latter are covered by policy with a casualty company. J. J. CAGNEY.

Liability insurance is not satisfactory, especially in large corporations. It does in some cases pay where plants are being constructed if it is carried for a short time.

JAMES R. SHURTZ.

A company can not afford not to carry liability insurance.

F. ELLWOOD SMITH.

Usually, the smaller the electric light company the greater the probability is that liability insurance will pay the company. In larger companies the reverse is usually the case.

ERNEST H. DAVIS.

We have found it profitable to carry liability insurance, both employers' and public, at the premiums obtainable, which, however, are very much less than the tariff rates. At anything like the tariff rates, we would not consider such insurance. I believe, however, that the large liability companies, through their organization and experience, can handle the company's liability covering accidents at a materially less cost than the company could through a separate organization. The question in each case will depend upon the liberality of rate that can be obtained from the liability company. THE BROOKLYN EDISON, W. W. FREEMAN.

The great objection to liability insurance is the fact that the insurance company's liability is limited and that a disposition is shown by most such companies to fight a case rather than settle. Cases have come to my attention in which the electric company had every opportunity to settle claims at comparatively small expense, but was restrained by the insurance people with the result that large damages were granted the plaintiff; of course, the insurance company paid to the limit of their liability, and the electric company had to pay the rest. S. R. INCH.

Z 16. Is the electric lighting company required by law to supply service to consumer with whom it does not care to do business by reason of consumer's unwarranted complaints, accusations of dishonesty, and so forth?

As a public-service corporation, it looks that way; surely you could convince your detractors of their mistaken and unwarranted opinions. F. D. SAMPSON.

Generally speaking, the law would require that service be rendered to any customer willing to pay regular price for it. The customer would be justly liable for a charge covering any expense incurred by the company on account of unwarranted complaints, especially if he is given one notice that he will be charged.
RALPH R. LAXTON.

Z 17. Could a consumer lawfully refuse to allow this company to remove wiring that had been placed on installment plan, in the event of non-payment or other cause?

There is a law that forbids removing anything from a consumer's premises if it is nailed. This is the manner in which moulding work is usually installed. If screws are used, however, the equipment may be removed. E. A. M., N. Y. ED. CO.

Yes. L. D. H. GILMOUR.

The doctrine of fixtures as well as the law of chattel mortgages varies in different states. Probably you could not remove wiring unless original contract specifically provided for removal, and you would then be liable for any damage to premises in removing it. RALPH R. LAXTON.

Not lawfully, nor morally; but they do refuse, and where, as is usually the case, the customer is not financially responsible redress is too expensive. L. D. H. GILMOUR.

Z 18. A company has 500-volt direct-current and 110-volt alternating-current mains all over the city. In order to improve the service and cut down operating expenses, the company wishes to do away gradually with its 500-volt business. Can it refuse to connect a man who demands 500-volt current?

The company would certainly have a right to refuse a man service under these conditions. F. D. SAMPSON.

Usually, an explanation of the situation will have the desired effect. A. PETERS.

I have known this to be done and think it perfectly legal unless franchise specifies some particular class of service. It would be bad public policy to restrict improvements legally.

RALPH R. LAXTON.

It can, and may be compelled to lie out of it afterward.

L. D. H. GILMOUR.

Z 19. Hadn't the public-service corporations better "come down the pole" and admit gracefully that the people have the right to fix reasonable rates, where prevailing rates are proven by proper examination to be unreasonable?

They most certainly would better agree to give up unreasonable rates. BIRMINGHAM RY., LT. AND PR. CO.

If a company charges unreasonable rates it is only standing in its own light. It is much better to get twice the business at twelve cents than the half at fifteen. A. PETERS.

Mark Twain once observed, referring to a person kicked to pieces by a mule, that "a very small piece of some people would assuage a great deal of grief." A small reduction in price voluntarily made is always more satisfactory to the customer and of more advertising advantage to a corporation than a larger reduction made under compulsion. L. D. H. GILMOUR.

Yes; they have no rights except such as are derived from the people, and sooner or later the people can in some way restrict or abolish them. The "high perch" is very insecure.

RALPH R. LAXTON.

UNCLASSIFIED

1. How can the medical profession be awakened to the necessity of attempting to revive persons shocked into insensibility? The writer has had two unhappy experiences with doctors who grew indignant because their ability to discern between life and death seemed to be questioned.

This association should present proper papers on this subject to every medical journal and medical association, and if the necessary mailing list can be compiled send copies to every practicing physician in the country. **Warren Partridge.**

The best way would be for the injured man's friends to continue the work of resuscitation, and in case of success give wide publicity to the facts, stating conditions. This would undoubtedly make the medical man feel "cheap" and possibly have a beneficial effect when he was called upon to deal with a similar case.

A. Peters.

I should think the leading medical journals would gladly publish any well-prepared articles on this subject, especially if based upon personal observation, or experience; and that the various state and national medical societies would find it an interesting and profitable topic for discussion. The twenty-ninth convention might place this in the hands of a committee, and possibly secure the assistance of one or more of the Federal medical departments in the work of disseminating information. Detailed statistical information would help managers to educate their medical friends along this line. **Ralph R. Laxton.**

2. Is there any electro-chemical process the product of which could be manufactured on a profitable basis by electric lighting companies, utilizing for this purpose the spare capacity available at low-load hours?

3. Could a practical wind-power plant of moderate cost be designed for electric lighting on farms in the prairie states, where winds are nearly as continuous as on the ocean beach?

Professor La Cour recently carried out a series of experiments on windmills for the Danish Government at Askow. The object of the experiments was the selection of the best type of windmill and the best arrangement of generating plant.

Professor La Cour found that a properly-designed four-vaned motor gave superior results to any other type, especially as regards suitability of speed for dynamo driving with moderate speed reduction. The power available from a given mill varies with the speed of the wind in accordance with the following expression:

$$\text{Horse-power developed} = \begin{array}{c}\text{Area of vane}\\ \text{surface in}\\ \text{square metres}\end{array} \times \left(\begin{array}{c}\text{Speed of wind}\\ \text{in metres}\\ \text{per second}\end{array}\right)^3 \div 1{,}250.$$

Thus, with a vane area of twelve square metres and a wind velocity of six metres per second, the horse-power available = two. With velocities of four, eight and ten metres respectively, the horse-power = five-eighths, five and ten approximately, or, allowing for loss due to air friction, the available horse-power in the four cases would be about one-half, one and three-quarters, four and one-quarter and eight and one-half. The windmill should be self-adjusting as regards the direction of the wind.

In order to maintain a uniform supply, some form of reserve supply must be available, which can be drawn on during windless periods. The most suitable reserve in the case of large installations consists of a petrol motor, and for small ones of a horsed capstan. The employment of such a reserve reduces the cost as compared with that of accumulators sufficiently large to meet all the conditions unaided.

As an example of the cost of such an installation suitable for a small village, Professor La Cour gives particulars of a station which has been supplying 450 incandescent lamps, as well as a few arc lamps and motors, for over two years at Askow:

Wind motor	$800
Petrol motor (as reserve)	800
Accumulators	1350
Dynamo	850
Gear	95
Switchboard and cell switch	95
Base	450
Mains	340
Total	$4180
Attendance, oiling and starting wind motor	$53.50
Attendance, etc., for petrol motor (during 30 days in the year at 4s. 6d.)	33.85
Petrol consumption per annum	53.50
Lubricant	21.90
Total	$162.75

The receipts for energy would amount to $680, giving an excess of receipts over expenditure of at least $510, or about twelve per cent on the capital expenditure of $4180. The cost of such an installation for an ordinary farmhouse is estimated at about $950, and the great advantage of such installations to the peasant population has led to the recent construction of a considerable number of them in Denmark.—*Elektrotechnik und Maschinenbau.*

It has been suggested that in place of the petrol motor and accumulator it might be possible in certain localities to use windmills to pump water into elevated tanks or reservoirs during times when a surplus amount of power is available and then use water power in times of shortage. EDITOR.

4. What improvement in the QUESTION BOX can you suggest?

One suggestion that I would like to make with regard to the *Question Box* is that the same questions crop up apparently from year to year. Possibly such questions could be printed and the answer given in a reference to preceding editions. This would save space and make a man value his *Question Boxes* and consult them when he got into difficulty. Another thing is, it seems to me, to save space, and this can be done by limiting the answers to the one complete one or the best one. I do not think it adds much value to a reply to have a lot of "yeses" and "noes"; all that sort of thing can be summarized. As to the length that answers are likely to run, we have a good example in the questions on meters, a good instance being U 6, where even the text of an ordinance creating supervision of meters is requested. One might as well ask for the copy of a patent or a law, it seems to me. A good many of the questions scattered through the box do not look to me like practical questions, but academic and theoretical, and I think the *Question Box* should be limited to the practical difficulties of the business.

There is no limit to the problems that can be discussed in any field if one will take the time and space. A good many of the questions, for example, under contracts and rates, advertising, accounting and statistics, are of this character, and many of them seem to me to go beyond the scope of the *Question Box,* as originally understood and as successfully carried out, if its publication is not to become too onerous on the association.

T. C. Martin.

It would seem that most of the questions answered by parties are answered briefly, and it would be well if they were entered into a little more in detail so as to bring out, if possible, the method of arriving at the results given in answer to the questions, even at times calculating the problems and giving them in such a manner that a layman could understand them.

A. E. Walden.

It seems to me that if previous issues of the *Question Box* were referred to more frequently, and if questioners made ordinary efforts to obtain answers to their questions from sources that are readily available, it would save a great deal of repetition, work and space in the yearly *Question Box.*

While I recognize the fact that the association is constantly increasing in membership and that new members can not refer to previous issues, making the complete elimination of all repetition inadvisable, I still believe that somewhat closer censorship than has been practiced heretofore in this regard is a move in the right direction. Alex J. Campbell.

The question of the proper use of incandescent lighting is something to which little study has been given in the past, but to-day the knowledge on this subject is growing with wonderful strides; people realizing that the problem is not solved by simply putting so much light into a room, but that good illumination, which is what the customer is paying for, is an engineering study of the highest practical importance to both the customer and electric light company. I would most decidedly suggest that in next year's *Question Box* such questions of illumination be included as those given in Mr. Burnett's paper before the Illuminating Engineering Society at its April meeting, 1906.

Van Rensselaer Lansingh.

5. Is there a watch permanently immune from irregularities due to stray fields?

The $2.50 watch of the New England Watch Company is entirely immune from magnetic effects, but it is not a remarkably accurate timekeeper. Dugald C. Jackson.

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INDEX—II

QUESTIONS

NOTE—Questions marked (*) are included through the courtesy of Mr. Henry L. Doherty, editor of the 1906 Question Box of the Ohio Gas Light Association.—EDITOR.

A

QUESTION

BUILDINGS

A 1 Give cost per cubic foot of recent station and substation buildings, stating briefly general characteristics as to material, construction and kind of foundation.—p. 3.

*A 2 Does too much water in concrete have bad effects, and if so what are they?—p. 5.

*A 3 Is it advisable to use water-gas generator clinkers and ashes for concrete instead of stone in any kind of foundation work?—p. 6.

A 4 Is it desirable to employ the all-concrete construction for power-house buildings?—p. 8.

A 5 Assuming that for short spans all-concrete and for long spans steel-truss roof construction is the cheaper, at what width of span is the turning point?—p. 8.

A 6 Where it is desirable to make the crane available for handling machinery in basement, such as condensers, pumps, valves, piping, etc., can you suggest any better removable flooring than iron or steel plates?—p. 9.

A 7 Is it safe to use a cement floor in a room where alternating-current machinery, operating at 2200 volts or higher, requires handling of the parts by operator?—p. 10.

A 8 What kind of materials are best for (a) foundations for dynamos and engines? (b) Floors for engine and dynamo-rooms?—p. 11.

A 9 (a) Is concrete-block construction suitable for central-station buildings? (b) Is it found practical to plaster on concrete blocks with double air space, in cold climate, without additional lathing and plastering?—p 14.

B

WATER-WHEELS, WATER-POWER, ETC.

B 1 What percentage of friction is there in a rope-drive from vertical water-wheel to horizontal shaft?—p. 14.

B 2 In a combined water-power and steam plant, is it practical to use the overflow from condensers for the purpose of preventing or reducing troubles due to ice?—p. 14.

QUESTION

B 3 How does frazil or anchor ice affect your plant? (a) Does it block your racks? (b) Does it reduce the output of your water-wheels? (c) Does it stick the gates and thus make regulation impossible?—p. 15.

B 4 What is the lowest head under which satisfactory operation of horizontal turbines can be secured?—p. 17.

B 5 What is the most desirable way to set horizontal turbines for operation under 30-foot head?—p. 17.

B 6 What methods are used to prevent racks clogging with ice where from 300 to 400 cubic feet of water are used per second?—p. 17.

B 7 In a water-power plant of moderate size (about 1000 horsepower) and moderate head (60 feet or thereabouts), what is the best method of avoiding possible water-hammer in the penstock or wheel case? Should relief valves be installed or a standpipe, or both?—p. 18.

B 8 Where a standpipe is installed to prevent water-hammer, is it necessary in northern climates to heat the water, or will the ordinary surging of the water in the pipe be sufficient to prevent freezing?—p. 19.

B 9 Are there other successful methods of transmitting power from vertical turbines to horizontal shafting besides bevel gearing? Where are they employed?—p. 20.

B 10 What are the main advantages of double-discharge horizontal turbines over centre-discharge turbines?—p. 21.

B 11 What is the maximum per cent of speed variation from one-quarter load to 25 per cent overload in a water-turbine generator, and does the water consumption vary in the same ratio for various loads as the steam consumption of a steam turbo-generator?—p. 21.

B 12 This winter ice has gathered on the inside of our steel penstock (which is 1600 feet long and 6 feet in diameter) during the daytime when we are shut down. Then when we begin the night run it breaks off and runs into turbines for two or three hours, making much trouble. What is the remedy?—p. 21.

B 13 An article in an electrical journal states that increasing the grate surface will prevent ice from forming on the grates. Has anyone tried this and with what success?—p. 22.

B 14 Give good method of providing against the burning out of wooden step-bearings on vertical water-wheels, caused by insufficient lubrication.—p. 22.

C

FEED WATER, ETC.

*C 1 Should wooden water tanks be painted, or how treated?—p. 23.

*C 2 In wooden water tanks should the heart side of the wood face in or out?—p. 23.

QUESTION

C 3 Is it good practice to install a feed-water heater by-passed by a direct exhaust to the atmosphere?—p. 24.

C 4 Give a good way to remove scale in a closed heater, by boiling with some solution or reagent, for instance, without taking heads off heater or using mechanical tools.—p. 25.

C 5 Give compound formula for water, the impurities in which are 65 per cent calcium sulphate, 13 per cent calcium carbonate and 22 per cent other substance.—p. 26.

C 6 Boiler feed water is impregnated with tar from a nearby water-gas plant. What effect will the tar in time have on the feed pipe, pump, valves and boilers, also on engine cylinders? And what is the best method of extracting the tar from the water? —p. 26.

C 7 How much heating surface is usually allowed per horse-power in a closed feed-water heater?—p. 26.

C 8 Are recording thermometers sufficiently accurate to justify their use in recording temperature of boiler feed water when thermometer is placed 100 feet from and 15 feet above point of connection on feed pipe?—p. 27.

C 9 Is an electrically-driven feed pump more reliable and economical than the ordinary steam-driven pump?—p. 27.

D

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D 1 Where necessary to have practically smokeless combustion, is it possible to burn bituminous coal, and, if so, under what conditions of boiler equipment and firing?—p. 28.

D 2 What size of air openings in grates is the most advantageous when using Hocking screenings under water-tube boilers, with a stack 60 inches diameter and 150 feet high, or a draft of one-half inch?—p. 33.

D 3 (a) What is the fuel cost per kilowatt-hour? (b) Give capacity and characteristics of station. (c) Give kind of fuel used and cost per ton.—p. 33.

D 4 (a) How many pounds of coal per kilowatt-hour at switchboard are consumed in members' plants—condensing, non-condensing, etc.? (b) Same for turbines. (c) Same for cubic feet of gas in gas-engine station, stating kind of gas. (d) State capacity and characteristics of station.—p. 36.

D 5 What efficiencies are obtained with different kinds of coal?—p. 36.

D 6 Calling big-vein George's Creek bituminous coal 100, give the value of various kinds of bituminous coal, anthracite coal, coke and coke breeze in percentages of this figure.—p. 37.

D 7 What are the heat values of coal used by the different companies?—p. 38.

D 8 Give heat values in B. t. u. of gas coal, coke and George's Creek big-vein coal.—p. 38.

QUESTION

D 9 Which is the more economical, run-of-mine at $2.00 or nut coal at $2.25?—p. 38.

D 10 In locations where freight on coal is from $1.10 to $1.30, what grade, from domestic lump to nut and slack, will generate most steam for least money, under horizontal tubular boilers loaded to rating?—p. 39.

D 11 Quote any actual tests obtainable as to the efficiency of Roslyn, Washington, and Rock Springs, Wyoming, coal.—p. 40.

D 12 What is the effect of weathering on different kinds of coal? —p. 40.

*D 13 How deep may soft coal be piled with safety, without providing any ventilation?—p. 41.

D 14 Can the degree of liability to spontaneous combustion in bituminous coal be determined by chemical analysis?—p. 42.

D 15 What style of furnace is best suited to burn coke, and what is the effect of burning coke on the brick setting?—p. 42.

D 16 What success has been attained by burning coke breeze and culm with the aid of forced draft?—p. 43.

D 17 Can you furnish data on methods and results of using gas tar as boiler fuel?—p. 44.

*D 18 What efficiencies have been attained in firing steam boilers with natural gas and with producer gas?—p. 44.

*D 19 What is the most economical method of generating gas for power plants?—p. 44.

*D 20 In using gas as boiler fuel, what is the best arrangement, construction, gas pressure and air dilution?—p. 45.

D 21 Has anything been done in this country, outside of municipal plants, in the use of garbage as fuel?—p. 45.

D 22 What is the best kind of coal-handling apparatus?—p. 45.

D 23 What is the average cost of coal-handling per ton? State conditions.—p. 46.

D 24 What is the comparison of B. t. u. per pound in Pennsylvania bituminous and English Welsh coal?—p. 47.

D 25 Give comparative values of coal and oil for boiler fuel.—p. 47.

D 26 What is the best method of preventing coal-storage fires in bituminous coal, and what is the best method of putting out same when once started? Coal is stored out of doors on the ground and is leveled off at a height of 12 feet.—p. 48.

E

BOILERS AND MECHANICAL STOKERS

E 1 (a) What success have you had with superheating boilers? (b) Do superheating boilers work well in multiple with other boilers? (c) Would you advise independent superheaters instead of superheating boilers to supply superheated steam to turbines?—p. 49.

E 2 (a) Are internally-fired boilers—Morrison type—satisfactory for

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electric-power plants? (b) Will they stand forcing for peak loads? (c) Why are they usually "leaky"?—p. 50.

E 3 In a station of 5000-kilowatt capacity or less, has the mechanical stoker shown any actual economy in labor or fuel as compared with hand-firing? If so, how much?—p. 50.

E 4 In an electric light plant of about 400-kilowatt capacity, using soft coal screenings at $1.25 per ton, would it be an advantage to install mechanical stokers?—p. 51.

E 5 What type of mechanical stoker is best for small central station giving a 12-hour service?—p. 52.

E 6 (a) What detail methods of firing have been adopted to secure smoke abatement? (b) State conditions under which same were applied.—p. 52.

E 7 Give type of smoke consumers that have produced good results, stating boiler conditions under which same were installed. p. 53.

E 8 What is a reasonable expenditure for boiler compound per horsepower-hour?—p. 53.

E 9 Using hard water, is it possible to keep boiler tubes absolutely clean by use of proper compound, or does a compound allow a thin scale, one-sixteenth inch or less, to form and merely keep it soft? Briefly, what is the best result one can expect under these conditions?—p. 54.

E 10 What would be considered fair fuel economy over a month of regular operating work when burning bituminous coal in a hand-fired furnace, and under similar conditions what should it be if the same grade of fuel were fired on a chain grate?—p. 55.

E 11 What is the best stoker for horizontal tubular boilers of 125 horsepower each, say, for a battery of four boilers?—p. 55.

E 12 Why are mechanical stokers sometimes discarded after being installed?—p. 55.

E 13 What are the comparative advantages of motor and steam drive for automatic stokers in a light and power plant?—p. 56.

E 14 How should a 60-inch by 18-foot return tubular boiler be set and cared for so as to maintain tight brickwork?—p. 56.

E 15 What composition in fire-brick will best stand the heat and abuse common to a boiler furnace in a large generating station, without cracking or running too freely? Where is such a clay found?—p. 56.

E 16 What is the general experience in the use of chain grates with anthracite coal?—p. 56.

E 17 Our power-house is located at tide water. We have 2000-hp Stirling boilers equipped with "Tread-kill" shaker grates, 150 x 8-foot steel stack, natural draft. At times, when all conditions are apparently unchanged as to load, feed water, coal, etc., it is impossible to hold steam, while as a general rule it is no trouble. What is the cause and its remedy?—p. 57.

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E 18 What is the usual cause of burned-out tubes in water-tube boilers?—p. 57.

E 19 What is the comparative economy and efficiency of the Parker water-tube boilers and the Babcock and Wilcox water-tube boilers?—p. 57.

E 20 Would a foaming boiler give any bad results if not attended to in proper time?—p. 58.

E 21 Is there a steam-jet blower smoke consumer on the market that is economical and that consumes the smoke?—p. 58.

F

FORCED DRAFT, BLOWERS, STACKS

F 1 Has reinforced concrete in which broken fire-brick was used ever been tried for boiler-flue construction?—p. 58.

F 2 What is your opinion of a boiler flue constructed of ferro-inclave iron coated on the inside with concrete composed of broken fire-brick and cement, and on the outside with plastic magnesia covering?—p. 58.

F 3 (a) What is the life of a steel self-supporting stack, 60 inches by 120 feet high? (b) Used in the middle western states should a stack of this kind be lined or unlined?—p. 58.

*F 4 In erecting a riveted steel boiler stack made up of short sections, should the opening made by the laps between individual sections face up or down, and why?—p. 60.

*F 5 Have you ever calculated the chimney draft by formula and checked it with actual observation by thermometer and draft gauge? Give figures.—p. 61.

F 6 What is the most reliable formula or method of figuring the size of chimney for plant, having given: size of boilers and number, average kind of coal to be used? Same for cases where both chimney and fan are used?—p. 61.

F 7 What are the advantages, if any, of reinforced concrete chimneys over those made of brick, tile or steel?—p. 62.

F 8 Has anyone had sufficient experience with forced and induced draft, as applied to chain grates, to say what effect each has on boiler efficiency and capacity?—p. 62.

F 9 Are best results obtained by having automatic damper regulators control a single damper in main flue or a set of dampers in individual boiler flues?—p. 62.

F 10 What experience have members had with the McLean balanced draft system of the Engineer Company, of New York?—p. 62.

G

PIPING, CONDENSERS, ETC.

G 1 What is the best pipe-joint packing in steam lines having temperature of 550° F., pressure 150 pounds?—p. 62.

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G 2 What type and make of valve will best stand superheated steam? —p. 63.

G 3 What and how much is the benefit to be derived from the use of a dry vacuum pump in connection with a barometric jet condenser?—p. 64.

G 4 In figuring steam piping, what is the most reliable formula or means of figuring the size of pipe, having given: pressure at boiler and engine, distance to be carried, horse-power of engine or turbine? Also size of main in case x number of engines are to be supplied from the main?—p. 64.

G 5 Describe reliable methods for taking care of expansion in steam pipes?—p. 65.

G 6 What is the best expansion joint for use on a 50-foot straight run of 10-inch steam main carrying 150 pounds pressure? The joint to take care of contraction and expansion when steam is turned on and off about three times per week.—p. 65.

G 7 State briefly the principle of the barometric condenser.—p. 66.

G 8 What is the best method of determining the size of exhaust piping in cases where it is necessary to place the condenser at a considerable distance from the engine or turbine? What allowance should be made for elbows, both long and short turn, and what velocity of steam is allowable in such cases?—p. 66.

G 9 Which is more frequently installed in large plants, the surface or the jet condenser?—p. 67.

G 10 In a surface condenser, owing to the resistance of the nest of tubes, there is unavoidably a difference in vapor pressure between the point where the steam enters the condenser and the point where the dry air is removed. How low should this difference in pressure be in a well-designed condenser when operating at rated capacity?—p. 67.

G 11 An 800-kw railway unit having a cross-compound horizontal Corliss engine running at 80 r.p.m. is provided with a jet condenser, the water supply of which is controlled by a steam-driven centrifugal pump located at bottom of condenser's cone. There is also an independent steam-driven air-pump. A Schutte-Koerting light-pressure backwater valve is located between engine exhaust and condenser. Variations in load cause this valve to knock violently with every stroke of the engine. What is the reason and what is the remedy?—p. 67.

G 12 Give some good practical applications of the steam accumulator (Rateau, for instance) and give reasons for same based on actual results.—p. 68.

G 13 How often should injector be tested to be sure it is working properly?—p. 68.

G 14 Vibration of engine probably starts leaks under boltheads of flanges. What is the best way to stop it?—p. 68.

H

ENGINES

QUESTION

*H 1 Compare cost of steam-engine, steam-turbine and gas-engine installations; itemized if possible?—p. 68.

H 2 With conditions identical, is a fast or a slow-speed engine more economical?—p. 69.

*H 3 In gas-engine practice, what simple devices are there that will give the engineer some idea as to whether the proportion of gas and air is such as to give the greatest economy?—p. 69.

*H 4 What is the best way to determine the weight of the fly-wheel in designing a gas engine, in the case of an engine direct-connected to a generator, where the speed must not vary more than two per cent from no-load to full-load?—p. 70.

*H 5 What are the causes of the recent reversion from vertical to horizontal gas engines?—p. 71.

H 6 What is the best efficiency known of any type of steam engine from the coal pile to the switchboard? Ditto, steam turbines. —p. 71.

H 7 Will engines govern as closely under variation of steam pressure as under variation in load?—p. 72.

H 8 Will a stationary engine pull the same load as well running under as running over?—p. 72.

H 9 What are the allowable pressures per square inch in engine bearings, cross-head pin, crank pin and main bearing?—p. 73.

H 10 How can you determine the pressure on the guides of a horizontal engine for a given position of the cross-head?—p. 73.

H 11 Give information in regard to successful parallel operation of alternators driven by gas engines.—p. 74.

H 12 If a gas engine and producer can be installed at so low a cost as is claimed, can be run so economically and regulated so closely, why are not more large gas-engine-driven units installed? —p. 74.

H 13 What would be the cost of a 500-hp gas producer erected?—p. 75.

H 14 For a lighting plant in small towns of 1500 to 3000 fixed population, have gasolene engines used as prime movers proved successful? How do the plant investment and the economy of operation compare with those of the usual steam-engine plants? —p. 75.

H 15 How long are gas engines capable of operating continuously without abnormal deterioration?—p. 75.

H 16 What net efficiency is obtainable in every-day operation from (a) gas engines and (b) producer power plants of moderate capacity as compared with steam?—p. 76.

H 17 How does the cost of power compare with gas and steam?—p. 76.

I

TURBINES

QUESTION

I 1 Will the De Laval steam turbine of 50 to 100 horse-power replace a modern high-speed engine satisfactorily and show a gain in economy?—p. 77.

I 2 What advantage has the 500-kw turbine over the 500-kw engine where the question of space need not be considered?—p. 77.

I 3 Can a steam turbine be operated on the back pressures encountered in good steam-heating practice, with the same economy as a good reciprocating engine of the Corliss or four-valve type? —p. 79.

I 4 What troubles, if any, have been encountered in running turbines of the horizontal type against pressures of 16 to 20 pounds absolute; also of the vertical type, and if remedied, how?—p. 80.

I 5 Quote any actual tests made on a Parsons steam-turbine station running condensing, giving the coal consumed per hour when operating with no load with generator at full voltage only. State steam pressure and number of auxiliary engines in use. —p. 80.

I 6 In operating a Parsons steam-turbine station condensing, quote actual results, giving pounds of coal consumed per hour per kilowatt-hour recorded at the switchboard.—p. 81.

I 7 What temperature of superheated steam gives the best results on a Curtis turbine?—p. 81.

I 8 Which is better for use on the stepbearing of a Curtis turbine—water or a first-class oil?—p. 82.

I 9 Which gives better results on the stepbearing of a Curtis turbine —oil cooled by water coil or oil not cooled and used at a temperature of 160 degrees?—p. 83.

I 10 Has a Curtis turbine in which water is used on the stepbearing been known to go down on the step?—p. 83.

I 11 Are the blades, and discs holding same, in Curtis turbines stiff enough to prevent rubbing when heavy fluctuations in load occur?—p. 84.

I 12 (a) Have members ever heard of the striking of the buckets of a Curtis turbine? (b) How do these buckets wear in use?—p. 85.

I 13 In steam-turbine practice how high should the vacuum be maintained to secure the best economy of operation?—p. 85.

I 14 Has experience in the operation of steam turbines indicated the necessity or desirability of having a mechanical brake, water rheostat or other means of stopping the turbines?—p. 86.

I 15 What is the comparison in steam consumption per indicated horsepower of steam turbines and reciprocating engines, both of same capacity, being operated under the same conditions, with varying loads?—p. 86.

I 16 What is the difference of economy between a reciprocating engine,

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"Atlas" type, and a Curtis turbine, 5000-kw units, at their normal load; also the difference in pounds of steam between normal and light loads?—p. 87.

I 17 What is the known difference in efficiency of the station where reciprocating engine exhausts direct into condenser and that where the reciprocating engine exhausts into low-pressure turbine, which then exhausts into condenser?—p. 88.

I 18 Has the vertical-type turbine any material advantage over the horizontal type in the matter of compactness? How do they compare in modern turbine stations?—p. 88.

I 19 In a turbine plant where surface condensers are used, is it possible so to arrange the plant that condenser can be installed directly beneath the turbine without taking up extra floor space or head room? What is the extra cost for surface condensers installed beneath turbines?—p. 88.

I 20 Are any of the modern type turbines suitable for mounting on structural foundations?—p. 89.

I 21 Is high vacuum or superheat necessary to obtain good economy in the Parsons type of turbine?—p. 89.

I 22 Quote some certified tests on Curtis and Parsons turbines running on saturated steam; (a) on high vacuum 28 or 29 inch, (b) low vacuum 25 or 26 inch. State vacuum.—p. 89.

I 23 Why are some builders of turbines so much in favor of high superheat and vacuum, and others not?—p. 90.

I 24 In an emergency, how much time is necessary to erect and put into operation a turbine unit?—p. 90.

I 25 Where crane facilities are at hand, how much time is necessary for dismantling a steam turbine so that the rotor may be removed?—p. 90.

I 26 What is the longest continuous run on record for a turbine plant? —p. 90.

I 27 Is it possible to prevent air leakage around shaft of a steam turbine?—p. 90.

J

DISTRICT HEATING

J 1 Does district heating by hot water pay when there is not enough exhaust steam to take care of entire load?—p. 91.

J 2 In the use of direct-pressure district steam heating. (a) What rates are charged? (b) In what manner is the pressure regulated? (c) How should the pressure vary with the temperature? (Give records if possible.) (d) Is this method of district heating financially successful? (e) Give practical suggestions for successful operation and management.—p. 93.

J 3 Have central steam-heating plants proven a success in cities of over 100,000? Where?—p. 99.

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J 4 Can a district steam-heating system be made to pay when the average cost to the consumer is 30 cents per 1000 pounds of condensed water as measured by meter, the system not being provided with a return pipe to the plant? Cost of coal $1.85 per ton.—p. 102.

J 5 Can a direct-pressure, water-return, steam-heating plant be made to pay, using live steam exclusively, where the average cost of coal to the consumer is $7.50 per ton and to the plant $4.50 per ton?—p. 105.

J 6 What is the most satisfactory method of charging for steam heating—per thousand feet of cubical contents, square feet of radiation, or water evaporated?—p. 105.

J 7 Are there any steam meters in service for measuring the steam used by private consumer in varying quantities?—p. 106.

J 8 Can Parsons steam turbines be successfully used in connection with a district steam-heating plant, the turbines exhausting into the heating mains? When so used, how do turbines compare with cross-compound Corliss engines for economy of steam consumption, and is there any liability of distortion of the rotor with consequent stripping of the blades?—p. 107.

K

GENERATORS AND EXCITERS

K 1 Give briefly the advantages and disadvantages of direct-connected and belted units.—p. 108.

K 2 Has any installation of "umbrella" type generators been made for direct-connection to vertical water-wheels, and is the same considered good practice in this country?—p. 109.

K 3 What is the cause of arcing between segments of the commutator of an alternating-current generator?—p. 109.

K 4 Two belt-driven compound-wound generators—one 75-kilowatt and the other 100-kilowatt capacity—are arranged to be run in multiple. By itself the 75-kilowatt machine is slightly overcompounded, but the two run perfectly together. What would be the result if these machines were thrown together without the equalizer-switch being closed?—p. 110.

K 5 In case of emergency, could a 550-volt, compound-wound generator be run at 250 volts on the same 'bus with shunt-wound, 125-volt machines running on three-wire system?—p. 112.

K 6 What should be the ratio of capacity of the exciter to the alternator?—p. 115.

K 7 Are rotary converters being operated successfully inverted? —p. 116.

K 8 Why should a three-phase system, supplying rotaries and synchronous motors only, be other than in perfect balance, and how much does it vary in actual practice?—p. 118.

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K 9 If two or more inverted rotaries are running in parallel on the alternating-current side, is there a constant shifting of load on account of phase difference?—p. 118.

K 10 What is the best method of controlling automatically the frequency of inverted rotaries?—p. 118.

K 11 What has been the experience of those who have used in practical work a system of automatic synchronizing of rotary converters?—p. 118.

K 12 What has been the experience of large companies operating numerous large rotary converters as to the comparative merits of staggering every other set of carbon brushes on direct-current side with reference to one another, or of staggering by groups of adjacent positive and negative brushes with reference to one another? The latter method of staggering being used for the purpose of avoiding the uneven wear on the commutator, due to electrolytic deposition of copper on the face of the positive carbon brushes from the copper commutator immediately under the brush face.—p. 118.

K 13 Has experience ever shown that the end-play device on a rotary transformer is beneficial to the wear on the commutator?—p. 119.

K 14 Has general trouble been experienced with pig-tail brushes on rotary converters under abnormal overloads or at times of serious high-tension system disturbances?—p. 119.

K 15 What is the usual average power factor of a motor-generator system? State conditions.—p. 120.

K 16 In cases where the regular operating procedure of shutting down a rotary-converter unit equipped with an induction regulator provides for opening the fields of the converter before it comes to rest, has trouble been frequently experienced in subsequently starting the converter from the direct-current end, due to the residual magnetic condition of the static transformer?—p. 120.

K 17 Outline best method of starting up large systems of, say, 20,000-kilowatt capacity, in stations and substations with batteries after shut-down of all generators and converters?—p. 120.

K 18 What has been observed to be the limiting feature in connection with a rotary-converter equipment employing induction regulators, concerning maximum capacity of same?—p. 121.

K 19 Do turbines make a 60-cycle rotary system preferable to a motor-generator system?—p. 121.

K 20 Where a very large fluctuating power load is being run from the same motor-generator sets as the lighting load, what means should be employed to keep the pressure steady?—p. 121.

K 21 Is it practical to take two single-phase alternators, couple the shafts together and use them as a two-phase machine?—p. 121.

K 22 Is it economy to buy a three-phase alternator and use it for single-phase lighting?—p. 122.

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K 23 Can a 2200-volt, 125-cycle alternator be changed in speed and connected to generate 2200 volts at 60 cycles?—p. 123.

K 24 What advantages have compound over shunt-wound generators for substation work?—p. 123.

K 25 Are there any plants in the northwestern part of the country generating at 10,000 volts or more? If so, are all details of operation satisfactory, and are generators particularly liable to injury by lightning when used without step-up transformers? —p. 124.

K 26 I have seen a three-phase induction feeder potential regulator (2300-volt) which showed as great a loss (heat) in itself at no boost as at 120 volts boost. Is it a special feature of the regulator, belonging to this class, to have a rather low all-day efficiency?—p. 124.

K 27 How can we improve our power factor, which to-day has a minimum of 60 to 65 per cent and a maximum of 80 to 85 per cent, according to the load and the time of day? Our generating units consist of one 400-kw and one 600-kw, three-phase, 60-cycle, 2300-volt G. E. generators. Our day load averages 500 kilowatts, 90 per cent of which is three-phase power. Our street lighting, which is from the tub system and amounts to 155 kilowatts, has a power factor of 60 to 65 per cent. Our commercial incandescent and arc lighting, which has a peak load of from 200 to 300 kilowatts, has a power factor of about 90 per cent. Under the very best present operating conditions an 80 per cent power factor is about as high as we obtain. A loss of 20 to 25 per cent in generating capacity of central station is a serious condition.—p. 125.

K 28 A 500-kw, two-phase, 66-cycle, 2500-volt Stanley inductor-type generator, which when running under full load of incandescent lighting will carry equal voltage on each phase at terminal board, with a power factor of 90, when running on one-half load, consisting mostly of Westinghouse two-phase and Wagner single-phase motors, will drop its voltage very much lower on one phase than the other and will give a power factor of only 65. What is the trouble and what its remedy?—p. 126.

K 29 Give formula for good babbitt metal for high-speed generator? —p. 126.

L

STORAGE BATTERIES AND BOOSTERS

L 1 Would a storage battery in an alternating plant be a paying proposition to take care of part of peak load and furnish light power by day?—p. 127.

L 2 In plants where the exciters are not driven by separate prime movers, is it becoming general practice to install storage batteries and keep same "floating" on the exciter 'bus wires? Are the results satisfactory?—p. 127.

L 3 Why do not storage-battery manufacturers rate their products for efficiency and capacity in kilowatt-hours instead of ampere-hours? Is it because near end of charge the e. m. f. of generator has to be raised considerably and this would bring the efficiency in kilowatts low, the increased e. m. f. falling as soon as charge is discontinued?—p. 129.

L 4 What is the usual efficiency of a storage battery in kilowatt-hours, *i. e.*, percentage of efficiency between, say, a month's input in kilowatt-hours and month's output in same? The battery being well cared for and having maximum charge once a week, other charges being kept three points low.—p. 129.

L 5 What are the objections, if any, to discharging batteries at high rates in case of emergency?—p. 130.

L 6 If, in case of an emergency, a storage battery is carrying the entire load of a substation and the interruption continues beyond the capacity of the battery, when should the battery be disconnected?—p. 130.

L 7 What are the comparative advantages of the high-voltage rotary and the booster set for charging the battery in a rotary battery substation?—p. 131.

L 8 Is an exciter battery necessary to insure the protection of central-station service against exciter-current interruptions?—p. 132.

L 9 What is the average life of positive plates in terms of equivalent complete discharges?—p. 133.

L 10 What experience have you had with, and what is the advantage of, the tray plate style of storage batteries?—p. 133.

L 11 Give method of keeping end cells, which are only used occasionally, in good, healthy condition.—p. 133.

L 12 What is the best battery-room floor construction?—p. 133.

L 13 What kind of paint is most serviceable for use on battery-room iron and copper work?—p. 133.

M

SWITCHBOARDS, INSTRUMENTS AND STATION WIRING

M 1 Can one phase of a three-phase system be used for single-phase lighting and other phases for power, by putting voltage regulator on lighting phase only?—p. 133.

M 2 What is the most satisfactory method of regulating the voltage of separate feeders operating from one generator?—p. 136.

M 3 Is it desirable to take three-phase current from 'bus-bars and change it to single-phase current without balancing three-phase system? How can it be done?—p. 137.

M 4 What kind of insulated wire is considered best to-day for station wiring at 2300 volts?—p. 139.

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M 5 How often should switchboard instruments, voltmeters, ammeters, indicating and recording wattmeters, be tested?—p. 140.

M 6 How much of a heavily-fluctuating railway load does a recording wattmeter actually register?—p. 141.

M 7 What is the best method of testing large-capacity recording wattmeters on direct-current railway switchboards?—p. 142.

M 8 What is the best method of determining, at the power-house, the total kilowatt-hours, generating at 11,000 volts?—p. 142.

M 9 Are automatic voltage regulators a paying investment and what make have you found to be the most satisfactory?—p. 143.

M 10 On a three-phase distribution system of about 1500 kilowatts, what form of regulator is most satisfactory to keep the potential of the three 'bus-bars properly balanced?—p. 144.

M 11 After the line-drop compensators are once set for alternating-current circuits, should they be re-adjusted, and how often? —p. 144.

M 12 Give opinion of the merits of ordinary separate-well, switchboard type, oil switches for use on high-tension transmission lines on rotaries.—p. 144.

M 13 What causes a G. E. 500-ampere, 4000-volt, type H motor-operated switch, supplying a 100-mile, 60,000-volt transmission line through a bank of step-up transformers, to open and close of itself?—p. 144.

M 14 On which side of large-direct current generators, running in multiple, is it common practice to place the circuit-breaker, and what are the chief reasons?—p. 145.

M 15 Describe any successful commercial installation of mercury arc rectifiers used as lightning arresters.—p. 145.

M 16 How often should bellows-type relays be calibrated, and what percentage of accuracy is it possible to maintain under ordinary conditions of operation?—p. 145

M 17 What is the best form of name-plate for switchboard work? —p 146

N

BELTS AND SHAFTING

N 1 What is the advantage of transmitting power by rope?—p. 146.

N 2 What is the best thing to use to stop belt slipping?—p. 146.

N 3 What experience have you had with Cling-Surface on narrow and wide belts? Is it better than no dressing?—p. 147.

O

OIL AND WASTE

O 1 What difference in the grade of cylinder oil is advised where 125° superheat is used in one case and saturated steam in another?—p. 147

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O 2 What is the average price of a good cylinder oil to be used with saturated steam and flat gridiron valves?—p. 148.

*O 3 What are the specifications for a suitable cylinder oil for water-cooled gas engines?—p. 148.

O 4 Is there any oil made that will work economically in a "crank-case"?—p. 149.

O 5 What is the cost per kilowatt-hour for cylinder oil? (State capacity and characteristics of station.)—p. 149.

O 6 What is the cost per kilowatt-hour of machine oil? (State capacity and characteristics of station.)—p. 150.

O 7 What is the cost per kilowatt-hour of waste? (State capacity and characteristics of station.)—p. 150.

O 8 How does the cost of using waste compare with the cost of using wipers in the larger power-houses?—p. 150.

O 9 Running a 225-horse-power high-speed engine at about half load, is it possible to use so small a quantity of cylinder oil as to increase friction in cylinder and valve chests to such an extent that it will noticeably increase fuel consumption and still not cause cutting? Briefly, if too little cylinder oil is used will it show first in cutting or in increased friction?—p. 151.

O 10 How much a gallon is it advisable to pay for cylinder oil for large Corliss engines?—p. 152.

O 11 Do you know of any place where the efficiency of lubricating oils can be tested? (To save the "hocus pocus" in the oil business a test bureau is necessary.)—p. 152.

P

OVERHEAD LINES

P 1 What methods have been devised, at once accurate and simple, for keeping records of city pole lines and the extensions thereto?—p. 153.

P 2 In keeping line records, are the results obtained by making a record of the exact location of each wire on every individual pole, either by pole cards, diagrams or otherwise, commensurate with the difficulty and expense of making these records and keeping them accurately up to date?—p. 155.

P 3 As good chestnut poles are becoming more difficult to obtain, what is the most satisfactory timber to use as a substitute in pole-line construction?—p. 157.

P 4 Is clear, hard yellow pine, Oregon fir or Maine spruce the best material for cross-arms; how do these woods compare as to strength and lasting qualities?—p. 158.

P 5 Is short-leaf yellow pine creosoted as satisfactory for cross-arms as hard yellow pine painted?—p. 159.

P 6 How can checking of cross-arms while being seasoned, and before being painted, be prevented?—p. 159.

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P 7 (a) What advantage, if any, is there in the use of iron towers in place of poles for a long-distance transmission line carrying from 40 to 60 kilovolts? (b) What is the comparative first cost; maintenance cost? (c) Will not the long spans used in tower construction make the line wires break more frequently than with short-span pole construction? (d) Will towers have more or less insulating resistance than poles? (e) Will tower construction stand heavy windstorms as well as a pole line? —p. 160.

P 8 Do you work on live circuits carrying a potential of 5000 volts or over, and if so, what precautions do you use?—p. 161.

P 9 Do you work on dead lines attached to the same pole-carrying circuits at 10,000 volts or more? If so, what precautions are employed?—p. 161.

P 10 Is insulation of any value on overhead lines carrying voltages between 2000 and 5000 volts?—p. 163.

P 11 Should wire insulation be maintained on overhead city wires carrying more than 2000 volts?—p. 165.

P 12 A ten-mile line of three No. 8 triple-braid weatherproof copper wire, built two years ago, has been tied in with No. 10 galvanized-iron wire. Would you recommend changing ties to No. 8 triple-braid copper at the present time? No trouble has as yet developed.—p. 166.

P 13 In 2300-volt overhead suburban and semi-suburban distribution, where the circuits extend over considerable territory, and with numerous branches, should primary fuses be placed in every branch, or only in the more important branches, or should protection be relied upon solely in the switchboard circuit fuses?—p. 167.

P 14 Where a network of secondaries is tied in together, is it advisable to fuse the section covered by each transformer and, if so, what relation should the size of fuse have to the secondary?—p. 169.

P 15 Is the Y-connection with grounded neutral preferable to the Delta-connection in a high-tension transmission line, and if so, why?—p. 171.

P 16 Do you voluntarily open your lines during severe lightning storms, or just preceding them?—p. 172.

P 17 (a) Do you permit joint occupancy between telephone, telegraph and fire-alarm wires with electric light feeders? (b) Is such joint occupancy required by the city or town authorities?—p. 174.

P 18 In case of joint occupancy of pole lines, what requirements do you make as to the responsibility for accidents, standards of construction, etc., that are imposed on the telephone and telegraph companies?—p. 178.

P 19 (a) Do you operate telephone circuits over the same pole line

QUESTION

that carries high-tension transmission? (b) Is the telephone service satisfactory? (c) What precautions are employed at the instruments?—p. 179.

P 20 What kind of safety devices are generally used by linemen working on 2300-volt lines?—p. 182.

P 21 Which is the better practice in cases of joint occupancy of pole lines—to have telegraph and telephone wires above and elec-light wires and feeders below, or vice versa? Give the reason why.—p. 183.

P 22 A three-phase, 2200-volt, 60-cycle line about seven miles long running parallel to a telephone line continually has a heavy static charge. What is the best way to overcome this?—p. 185.

P 23 Does your company supply service switch and cutout on overhead distribution? Do you find this practice advantageous? —p. 186.

P 24 Does your experience in the supply of current in districts where there is no underground service show the advisability of using an alternating or a direct-current system for the supply of current to motors? Why? What is the best system?—p. 187.

P 25 What is the greatest radius commercially practicable for a 110-220-volt three-wire direct-current system?—p. 189.

P 26 Assuming that in the use of four-pin cross-arms for single-phase work the ideal method of construction is to run the two wires on adjacent pins on the same side of the pole, is the saving in inductive loss effected thereby sufficient to warrant the increased cost of construction for guying arms that is made necessary when the above rule is followed for both primary and secondary work? 2000-volt primary, 110-volt secondary; population of the town 35,000.—p. 190.

P 27 In three-wire secondaries, if outside are No. 2 B. & S. gauge, what should the neutral be?—p. 192.

P 28 What is the best method of carrying low-tension, three-wire distribution mains through trees that are too large to admit of carrying the wires over them on poles; and has any system of cabling such wires been successfully used?—p. 193.

P 29 What is the practicability of the following plan? To facilitate the extension of five-wire service lines and avoid a multiplicity of wires, it is suggested that the five wires be encased in a light-weight weatherproof case. Give method of fastening to cross-arms and building?—p. 193.

P 30 What can be done to divert public sentiment against the unsightliness of overhead lines?—p. 193.

P 31 What results have been attained in the matter of treating poles to prevent decay at the top of the ground?—p. 195.

P 32 Are single-petticoated glass insulators good for 2200 volts?—p. 196.

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P 33 Are ordinary deep-groove double-petticoated glass insulators all right for 6600-volt alternating-current circuits?—p. 196.

P 34 (a) Is there any method for making joints with large sizes of aluminum cables which is not prohibitive owing to the size of the finished joint, the possibility of oxidization when used bare, or similar causes? (b) Is there any practical method for making a soldered joint and, if so, how?—p. 197.

P 35 Considering costs and difficulty of making satisfactory joints, does aluminum show any advantages over copper for either high-tension direct-current transmission to substations or low-tension direct-current distribution when the company's entire system is underground?—p. 198.

P 36 Considering costs and difficulty of making satisfactory joints, does aluminum show any decided advantages over copper for high-tension long-distance transmission work?—p. 198.

P 37 In order to increase the tensile strength of copper wire it is proposed to use a small core of steel. What effect will the presence of this steel have when the wire is used in transmitting alternating current?—p. 198.

P 38 On pole lines carrying 2200-volt alternating current, which is the better policy in connection with safety to linemen repairing or connecting lines or apparatus—to shut down the 2200-volt line at station or branch, or to leave all lines alive and have it so understood?—p. 199.

P 39 What are the usual precautions taken to protect arc trimmers in case 2200-volt, 60-cycle circuits come in contact with the series arc circuits?—p. 200.

P 40 (a) What is the best method of locating grounds on series alternating current arc circuits operating from constant-current transformers? (b) Can it be done successfully when circuit is in operation?—p. 200.

P 41 In a town where there are alternating-current wires, 2200-volt, single-phase; Edison three-wire, 110-220-volt direct-current and telephone wires on the same poles, is it good policy to ground the neutral of the three-wire direct-current line? Also one of the secondaries of the two-wire alternating-current distribution?—p. 201.

P 42 Can a high-potential direct-current, long-distance transmission system, say from 1000 to 20,000 volts, be satisfactorily installed with a grounded negative for one side of the circuit? If so, what would be the method of generating and how would this pressure be brought to a working pressure along the line?—p. 202.

P 43 What is the best position of ground wire with respect to the three line wires, i. e., on side, above, or in centre of triangle?—p. 202.

P 44 Where ground wires run down the side of the pole from transformers, lightning arresters, etc., what is the best way to protect the people from getting a shock on them in case wire should happen to be broken off just above the ground?—p. 203.

P 45 What effect has a grounded line in close proximity and parallel to a long high-tension transmission line at times of high-voltage surges?—p. 204.

P 46 Has any serious trouble developed due to static discharge where high-tension cables leave the overhead lines to go into conduits? If so, what is usually done to overcome the difficulty? —p. 205.

P 47 What is the best practice in caring for lightning arresters and keeping records of lightning storms and effects?—p. 206.

P 48 How many lightning arresters should be used per mile on an alternating-current circuit of 2200 volts?—p. 206.

P 49 What make of lightning arrester would be the best on construction carrying 1000 volts? How many are necessary per mile, and what method would be considered best to properly install ground wire from same? Formation of soil is stony. —p. 207.

P 50 Give good plan for grounding lightning arresters.—p. 208.

Q

UNDERGROUND LINES

Q 1 What is the best underground construction for one or two circuits in a village where company is required to run lines underground in a few places?—p. 209.

Q 2 Describe method of building waterproof manholes.—p. 210.

Q 3 What means do you employ to protect your cables in manholes from injury due to burnouts in adjacent cables?—p. 211.

Q 4 What devices, if any, are installed to relieve abnormal rises of potential in large cable installation?—p. 211.

Q 5 Which is the best practice, in running underground leads from 2300-volt, three-phase generators to switchboard and from switchboard to step-up transformers—to use three-conductor lead-covered cables or three single-conductor lead-covered cables, and why?—p. 212.

Q 6 How many times were your cables out of service in 1905 for repairs? Give character of insulation and dimensions of cable, size of copper, thickness of insulation, thickness of lead sheath, over-all diameter and approximate length.—p. 213.

Q 7 What member companies are using lead-covered cables for transmitting 25-cycle current underground at 15,000 volts or over? —p. 213.

Q 8 What member companies are using lead-covered cable for transmitting 60-cycle current underground at 10,000 volts or over? —p. 213.

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Q 9 If any of the companies are operating combined underground and overhead circuits of 10,000 or 15,000 volts or over, do they experience more trouble on these than with circuits exclusively underground, and what special protective devices do they install for this work?—p. 213.

Q 10 Does your company supply service switch and cutout on underground distribution? Do you find this practice advantageous? —p. 214.

Q 11 What should be the cross section of each strand in a copper cable consisting of 61 strands, in order that the resistance of such a cable shall exactly equal the resistance of a solid copper bar having a cross-section of 500,000 circular mils; it being necessary, of course, that the 61 conductors be twisted together to form the cable, each strand thus following a long spiral course?—p. 214.

Q 12 What is the best form of primary cutout box to be used in connection with 2000-volt transformers installed in manholes? —p. 217.

Q 13 Is it practical to operate large underground 60-cycle alternating-current secondary systems using single-conductor, lead-covered cables; if not, give reasons?—p. 217.

Q 14 Are potheads desirable on terminals of all alternating-current underground cables 1000-volt and over—one, two or three-conductors?—p. 217.

Q 15 What is the best method of holding lead-covered cables installed in fire-clay ducts to prevent them slipping?—p. 218.

Q 16 What is the maximum grade on which lead-covered cables can be installed in fire-clay ducts without special provision being made to prevent them slipping down?—p. 218.

Q 17 In a system of Edison three-wire underground cable mains installed in conjunction with a system of 500-volt underground cable mains, what is the best method of taking off services from each system?—p. 218.

Q 18 Give status of high-tension underground transmission as to highest permissible working voltage—not on a few individual lines, but for large system—and the actual commercial and operating advantages thus far experienced.—p. 218.

Q 19 It has been an acknowledged fact that on the Edison underground tube system the underground troubles come on, especially in the night, at low-load. Do the lead-covered cables now used have the same characteristics?—p. 219.

R

TRANSFORMERS

R 1 What is the largest transformer you use on poles? Give detail of method of hanging.—p. 219.

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R 2 What is the largest capacity of transformers advisable to install on pole line on two-phase motor work? What is best construction for suspending same?—p. 224.

R 3 What type of transformer—air-cooled, oil-cooled and water-cooled—has experience shown to be the most satisfactory for high-tension work, *i. e.*, for voltages exceeding 25,000?—p. 224.

R 4 What is considered good practice in changing oil in pole-line transformers?—p. 226.

R 5 Has any one experimented with any system of lightning arresters or spark-gaps across transformer terminals that will prevent or reduce the burning out of transformer primary fuses during lightning storms?—p. 226.

R 6 (a) In the use of 'bus lines for customers, do you use a 'bus line for each block of buildings, or do you sometimes extend the 'bus lines for more than one block? If so, how far? (b) What advantage is there in limiting the length of such 'bus lines? Reference is now made to a single-phase alternating-current house-to-house distribution outside of the main business section of the city.—p. 226.

R 7 Is there any reason why a transformer placed on the end of a line, with good lightning protection, should break down under normal load sooner than one under same load placed elsewhere on the line? Has any one found that it does?—p. 228.

R 8 What progress, if any, is being made for the grounding of secondaries? Is there any standard method yet adapted for universal practice?—p. 229.

R 9 Do gas companies anywhere permit the connecting to their pipes of ground connections from secondary electric systems?—p. 231.

R 10 Is the grounding of secondary electric systems by connection to water pipes being carried out anywhere in the country with knowledge and consent of the water company or municipality owning or controlling the pipes, and, if so, where?—p. 231.

R 11 Is the grounding of secondaries to water pipes in any way detrimental to the pipes? Is there any trouble to be anticipated from a universal application of this practice?—p. 232.

R 12 Where water pipes are not available for ground connections, either because they are not present or because their use is prohibited, what is the most satisfactory means of making effectual and permanent grounds for secondary systems?—p. 232.

R 13 What have you found to be the most satisfactory method of making ground connections of secondaries to water pipes? Give details.—p. 233.

R 14 State where articles giving information on the grounding of secondaries may be found in recent issues of electrical journals or association records.—p. 235.

R 15 What method can be employed to determine if the load on an alternating-current secondary system is balanced?—p. 235.

QUESTION

R 16 Has the mercury arc rectifier been used on commercial direct-current arc lines, from alternating-current primaries with constant-current transformers? What has been the result? What are its advantages? What is the life of the rectifiers designed for 6.6 or 7 amperes?—p. 236.

R 17 Is there any objection or good reason why two or more transformers of the same make, type, capacity and cycles, but of different voltage, should not be operated in parallel, *viz.*: 1-10-kw, 1040-2080 primary—104-208 secondary. 1-10-kw, 1200-2400 primary—120-240 secondary?—p. 237.

R 18 Has an immersed switch been used, located on the pole or in the transformer vault and operated from the interior of a building so as to cut the primary current off the transformers for the purpose of saving the core loss when current is off? If installed, would the interest on investment and maintenance of such an equipment be more or less than the core loss on, say, a 25-kw transformer not in use 5600 hours per year?—p. 238.

R 19 Will a choke coil in circuit between transformer and cutout prevent blowing of fuse due to lightning?—p. 239.

R 20 Give a diagram of the "Scott connection" and explain its advantage and application.—p. 240.

R 21 Which is the better practice on a two-phase motor circuit—two single-phase transformers or one multiphase?—p. 242.

R 22 Has serious trouble been experienced by way of breaking down insulation, etc., as a result of suddenly exciting large static transformers under full primary voltage with the secondary circuit open, due to the rapid variation of the magnetic flux on account of different points in the wave at which the transformer was last disconnected and again connected to the primary system?—p. 243.

R 23 Has trouble resulted anywhere to telephone or fire and police-alarm systems where an alternating-current secondary distribution system is permanently grounded on one side or the neutral and an accidental partial ground occurs on one of the other sides? Can such trouble be prevented, and how?—p. 243.

R 24 In a bank of transformers with three-wire secondaries properly balanced, can any one transformer be overloaded if the total number have capacity for load, and if so, to what extent will the others protect it?—p. 244.

R 25 Do you consider grounding one side of secondary for protection in case of cross or transformer breakdown sufficient protection against lightning where long secondaries are in use; that is, will this safely displace secondary arresters?—p. 244.

R 26 What has been the experience in the smaller stations with grounded secondaries as to current loss and lightning effects? —p. 245.

R 27 Is it practicable to install transformers in manholes likely to fill up with water. Is there a transformer on the market that meets that service? If so, please state relative cost to overhead transformers.—p. 245.

R 28 How often do you find it necessary to remove covers from transformers installed on overhead circuits to ascertain the height of oil and to refill these transformers with oil sufficient to cover the coils?—p. 246.

R 29 What ratio to total number of sockets connected (*i. e.*, connected load) should a transformer have when connected, first, to a single residence; second, when three or four houses are connected from the one transformer; third, when eight or ten are so connected?—p. 246.

R 30 Has any company tried the following system, and, if so, with what success? Adopt a system (such as a railroad wrecking train) to take care of interruptions to service by having a transformer of a certain size all ready connected to flexible wires of sufficient capacity and insulation and so arranged as to be readily placed on a wagon or automobile and speedily transported to point of demand and temporarily connected into circuit, allowing transformer to remain in wagon and placing a man on duty as watchman till daylight, when regular gang would arrive and make permanent repairs.—p. 248.

S

LAMPS

S 1 Where a company furnishes and renews standard size, clear-glass incandescent lamps, should special higher-priced lamps be charged for, and if so, on what basis should the charge be made?—p. 249.

S 2 Is the practice of giving free lamp renewals good business policy, and is it gaining or losing adherents?—p. 250.

S 3 Should a company furnish the first installation of incandescent lamps free?—p. 253.

S 4 Should good lamps returned by customers be exchanged and given out again or should the customers be required to return only poor lamps?—p. 255.

S 5 Should free lamp renewals be delivered by the company or customers be required to send old lamps in for exchange?—p. 256.

S 6 Where incandescent lamps are installed and renewed free, is it the practice to furnish extra lamps so that the consumer can replace burned-out or dim lamps?—p. 259.

S 7 Do you furnish first installation of Meridian lamps and renewals free? If so, how do renewal costs compare with the cost of renewing ordinary incandescent lamps on the same basis? —p. 261.

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S 8 What is the best way of marking incandescent lamps for the purpose of identification?—p. 262.

S 9 When a company furnishes first installation of incandescent lamps and furnishes renewals, the lamps at all times being the property of the company, does the value of the lamps on the lines represent a permanent asset, the same as arc lamps, meters, etc., owned by the company?—p. 262.

S 10 Do you find it advisable to loan incandescent lamp clusters free? What is your policy in regard to arc lamps?—p. 263.

S 11 If you do not furnish Nernst lamps free, how do you charge for the lamps, and how for the maintenance?—p. 264.

S 12 As a matter of policy, in districts where a meter rate prevails, is it advisable to introduce or encourage the use of osmium, tantalum or other high-efficiency lamps, even when these are to be supplied by the customer?—p. 265.

S 13 Should incandescent series street lamps be left in the socket until they burn out, or be replaced at predetermined intervals? —p. 266.

S 14 With a plant containing direct-connected units, 200-kilowatt capacity, coal $2.35, what should be the cost each, per month, for 12 series alternating street lights, 450-watt arc lamps?—p. 268.

S 15 What height above the street level do you consider most satisfactory for incandescent lamps in suburban districts heavily shaded by trees?—p. 269.

S 16 Has anything been done to give the fixtures used for incandescent street lighting a more artistic appearance so that they will compare favorably with the best fixtures used for gas or vapor mantle lamps?—p. 270.

S 17 Where series arc lamps are installed on mast-arms using Cutter pulleys, what has proved the best method of securing the end of the rope to prevent meddlers from releasing the lamp? —p. 270.

S 18 What particular method of suspending and insulating a series commercial arc lamp and the service wires to it, secures the greatest protection from accidents and damages caused by rain and wind?—p. 271.

S 19 What is the best insulator to use as a break knob on commercial series arc lamps in the suspension?—p. 275.

S 20 What is the best insulator to use on a T-iron to support the leading-in and leading-out wires to a series commercial arc lamp?—p. 275.

S 21 Does the placing of spark gaps across series arc lamp terminals absolutely prevent the burning out of lamp coils during lightning storms?—p. 275.

S 22 What actual life per trim is being obtained from the different types of alternating and direct-current series enclosed-arc lamps? State maker; alternating or direct current; amperes;

length and size of carbons; average number of carbons per trim.—p. 275.

S 23 (a) What is the average breakage of inner globes? (b) What is the minimum?—p. 277.

S 24 What is the power factor of the various systems of (a) alternating-current arc lamps (series); (b) of constant-current regulators; (c) of complete systems of various makes? —p. 278.

S 25 What success have you had with the flaming arc compared with open and enclosed arcs?—p. 278.

S 26 Do you find the arc lamp as popular as formerly in pushing new business? Is your percentage of growth or the number of arc lamps connected as great as of incandescent lamps? —p. 278.

*S 27 Is the electric-arc or the gas-arc lamp better for discerning colors?—p. 279.

S 28 What candle-power of incandescent street lamp is the most advantageous from an operating standpoint?—p. 281.

S 29 Has any one of the various candle-powers of incandescent lamps used for street lighting predominance enough to be called standard?—p. 281.

S 30 What is the best 2000-cp arc lamp suitable for a direct-current series arc system for street lighting using a Western Electric arc dynamo (60-lt) which can be adjusted to from 7 to 10 amperes?—p. 282.

S 31 Where the voltage variation ranges from 90 to 115 (largest variation in daytime), what lamp would you recommend for general use as regards wattage and voltage? Meter system is used.—p. 282.

S 32 In what proportion does increase or decrease in voltage of circuit over or under that of lamps in service effect consumption? —p. 284.

S 33 What is the actual life of 16-cp, 3.5-watt and 3.1-watt lamps used on metered systems with a connected load of from 5000 to 10,000 lamps?—p. 284.

S 34 Will it shorten the life of an ordinary incandescent lamp to burn two in series on a circuit, the voltage of which is twice that of a single lamp?—p. 285.

S 35 What are the weak points of renewed lamps? Do they usually have a long life? Do they lose their candle-power rapidly? —p. 285.

S 36 A 16-cp, 110-volt lamp that was turned off, suddenly exploded. Can you give a cause for the explosion?—p. 285.

S 37 What are your rules governing the first installation and renewal of incandescent lamps?—p. 285.

S 38 What is the cost of operation of the Cooper Hewitt lamp as compared with that of incandescent arc lighting?—p. 286.

S 39 Have mercury arc rectifiers proved satisfactory on series arc circuits?—p. 287.
S 40 What is the quality of the light of arc lamps supplied by mercury arc rectifier as compared with that of lamps supplied by constant-current generators?—p. 287.
S 41 Describe any system of flaming arcs, giving characteristics peculiar to a system of this kind.—p. 288.
S 42 Is the flaming arc lamp making any material inroads on standard enclosed-arc lamp business?—p. 289.
S 43 What should be the renewal, from all causes, of globes per lamp per year on series open street arcs using best globes obtainable?—p. 289.
S 44 We run a 440-volt line about one-half mile for supplying four street lights. Four 110-volt lamps in series. A record for two years shows the lamp farthest away from the station burns out first, five to one. Why?—p. 289.
S 45 In connection with a single-phase electric railway it is proposed to do a lighting business. Is incandescent lighting satisfactory at 25 cycles, and, since arc lighting is not satisfactory at this frequency, can Nernst lamps be used with good results? —p. 290.
S 46 What is the cost per kilowatt-hour for care and maintenance of Nernst lamps?—p. 291.
S 47 What should be the percentage of depreciation charged against Nernst lamps?—p. 292.

T

HEATING, BATTERY CHARGING AND POWER

T 1 What is the best way of introducing heating appliances?—p. 292.
T 2 Should heating appliances be sold at cost?—p. 294.
T 3 What is your actual average revenue per month from an electric iron?—p. 295.
T 4 Should the automatic handle on electric laundry irons be required by the National Board of Fire Underwriters?—p. 296.
T 5 Does electric heating in the present state of development call for a special rate by the central station?—p. 296.
T 6 At what rate per kilowatt-hour will electricity compete favorably with dollar gas for cooking?—p. 298.
T 7 At what price must electricity be sold for heating to be on a par with gas at $1.00 per 1000 cubic feet?—p. 298.
T 8 At what rate per kilowatt-hour will electricity compete favorably with dollar gas for residence heating?—p. 299.
T 9 How large a single-phase motor do you permit on your general lighting supply mains? What size single-phase motor have you found would actually interfere with proper regulation of your general lighting supply mains?—p. 299.

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T 10 What is the best method for starting induction motors without the aid of a starting compensator, motors ranging in capacity from 50 to 150 horse-power?—p. 301.

T 11 Owing to compensator types of polyphase motors taking as high as seven times full-load current at starting, should not the inside wiring be large enough that no excessive drop in volts occurs, or the Underwriters' safe-carrying capacity is not exceeded at starting?—p. 301.

T 12 Is it good policy to install single-phase alternating-current motors when frequency is 133 cycles?—p. 302.

T 13 Which is the better for general power work, a motor with a high or low efficiency?—p. 303.

T 14 What would be the general effect on a three-phase system if induction motors were run constantly 15 per cent below their rated pressure?—p. 304.

T 15 Why are two-phase motors cheaper than single-phase? Which motor wears the better, single or two-phase, on same kind of work? Is there any difference in consumption of a 3-hp single-phase as compared with that of a 3-hp two-phase motor?—p. 305.

T 16 What has been the experience of electric light companies in introducing the use of motors for refrigerating plants?—p. 306.

T 17 At what price per kilowatt-hour will electricity for motor power compete favorably with natural gas at 27 cents per 1000 cubic feet? Gas has a value of 1000 B. t. u.—p. 306.

T 18 What has been the experience of companies with regard to electric heating?—p. 306.

T 19 What special discount is given, if any, to customers using small heating appliances or motors not large enough to justify a separate meter?—p. 306.

T 20 Can the heat given off by transformers and regulators in a substation be used to any advantage?—p. 307.

T 21 What has been the experience with companies with welding transformers on their lines in regard to voltage regulation? Transformers 15-kilowatt or larger.—p. 307.

U

Meters

U 1 What is a good formula by which to assign the sizes of meters for different numbers of lights (and various amounts of power) in different classes of buildings?—p. 310.

U 2 Which would be the best system of installing meter—selling to consumer or renting, or requiring a deposit to cover cost of meter?—p. 311.

U 3 What is the best explanation or reason to give customers for requiring a meter deposit?—p. 313.

QUESTION

U 4 Should more than one meter deposit be required from a customer having a meter at his place of business and one at his residence?—p. 315.

U 5 What limit do you impose on the number of meters installed on the premises of any one customer; and what charge, if any, or what difference do you make in the rate or minimum charge, if more than one meter is installed?—p. 315.

U 6 (a) In case a city intends to provide for testing and inspection of electric meters under municipal supervision, should the electric light company encourage or impose such a move? (b) Is there municipal supervision of electric meters in any city at the present time? (c) Give text of ordinance creating such supervision.—p. 317.

U 7 Do meters which test O. K. in meter-room become inaccurate through handling while being placed in circuit?—p. 321.

U 8 Is it usual practice to test meters in circuit a few weeks after they are put up?—p. 322.

U 9 What is the most satisfactory method of testing meters on customers' premises, and how many meters per day can one man test by the method given?—p. 324.

U 10 In testing large consumers' meters requiring current transformers, what is best practice—to test with or without current transformer?—p. 326.

U 11 What is common practice in regard to the re-calibration of customers' meters? How often should they be re-calibrated? —p. 327.

U 12 If a meter is correct on light loads, will it be always so on half and full loads?—p. 329.

U 13 Would it pay a small station having about 500 meter customers to keep a man just to read meters, to keep meters in repair and to test same; and how often should they be tested? —p. 330.

U 14 What is your basis of districting the city in your alternating-current territory? Do you read meters according to your lighting feeders, or do you adopt a purely arbitrary district line?—p. 332.

*U 15 What are the best methods to use to eliminate errors in reading meters?—p. 335.

*U 16 Would it not do away with many complaints if meter readers would leave a duplicate reading with the customer?—p. 336.

U 17 What has been your experience with direct-current meters for power purposes on 220-440-volt three-wire circuits?—p. 338.

U 18 What are the drawbacks to the Sangamo direct-current integrating wattmeter?—p. 338.

U 19 What are the principal service troubles with the new General Electric type C Thomson recording wattmeter?—p. 338.

U 20 (a) In connecting Thomson recording wattmeters are the markings of the connections strictly adhered to in practice?

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(b) Does meter man carry a voltmeter to determine polarity of wires? (c) Should service connections be changed to bring in wires correctly? (d) What effect will a connection not made according to marking have upon the operation of the meter?—p. 338.

U 21 What methods are used in overcoming the humming of a meter? Have such methods permanent results?—p. 340.

U 22 What has been the experience of lighting companies in cities of from 50,000 to 150,000 inhabitants in regard to exacting deposits?—p. 340.

U 23 In testing meters should tests be made at light, half and full loads, and the average taken?—p. 341.

U 24 Is it better to put a meter in each phase of a two-phase motor circuit or to use a polyphase meter?—p. 342.

U 25 (a) Suppose that a building wired on the three-wire Edison system is connected to a four-wire, three-phase distribution for lighting service with 115 volts between the neutral and any one of the other three wires and 200 volts between any two of the three-line wires. The service wires to the building would be connected with the neutral on the line and with two of the outside wires, making a three-wire connection with 200 volts between the outside wires and 115 volts between line and system. Will an ordinary Edison three-wire meter register the service correctly or will it be necessary to install two single-phase meters with 115-volt potential windings? (b) What will be the error with the three-wire meters? —p. 342.

U 26 Why does one meter register more than the other on two-phase circuit for a single motor?—p. 343.

U 27 In metering current for a two-phase motor, a separate meter being placed on each phase, what methods are used to prevent reverse registration on either meter due to power factor? What method is used in billing an account with such reverse registration?—p. 343.

U 28 Will a 220-volt, two-wire, direct-current meter record accurately on a 220-volt, three-wire circuit?—p. 344.

U 29 Are polyphase meters in a state of experiment, or is there any weakness in them? Why are they not in general use, or why is it that large companies have not adopted them?—p. 344.

U 30 Electric meter manufacturers claim that meters will stand 50 per cent overload for a short time; is it not true that electric meters will carry overloads much in excess of what manufacturers claim for them?—p. 345.

U 31 What size meter would you advise for use on building containing 100 16-cp lights, one-fourth of same being in use about nine-tenths of the year?—p. 346.

U 32 What investigations should be made by meter testers? Should they endeavor to ascertain the load used, recount the connected load, etc., or should this be done by a separate department?—p. 347.

U 33 What is the cost of meter maintenance on a 3000-meter installation that is kept up in good shape? Thomson recording wattmeters and induction meters used.—p. 348.

U 34 In a city having 9000 meter customers, which is considered the better method to read meters; large force of readers during last few days of month, or divide city into districts and take readings on, say, tenth, twentieth and thirtieth of month? —p. 349.

U 35 What has been the experience with companies with regard to prepayment meters?—p. 349.

U 36 How do you keep record of meters from the time they are received from factory until they are disposed of as useless? —p. 350.

U 37 Describe a convenient portable load device for meter testing. —p. 351.

V

ADVERTISING

*V 1 What advantages are to be gained by a commercial department, and why?—p. 351.

*V 2 What relation should the commercial department bear to the other departments of the company?—p. 352.

*V 3 Should a gas and electric company push the sale of gas engines or electric motors?—p. 353.

*V 4 What effect, if any, does the commercial department have on the market values of electric and gas stock of companies having such departments?—p. 354.

*V 5 How do the reports of companies having new business departments compare with reports of companies without such departments?—p. 355.

*V 6 Name the cities in the United States where electric light companies have a regularly organized commercial department. —p. 355.

*V 7 How much is an electric light company justified in spending for the securing of new business per dollar of revenue thus secured?—p. 355.

V 8 What percentage of your gross receipts do you find it advisable to expend for your total advertising appropriation, including your bulletin and publicity expenses and your regular advertisements?—p. 356.

V 9 Give the percentage of the total amount appropriated to be devoted to each of the different ways of securing new business. —p. 356.

V 10 Assuming an annual advertising appropriation of from $5000 up, is it better for a public-service corporation to lay out its

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own advertising campaign in its own office in view of local conditions, or is it better to place the matter in the hands of some advertising concern of recognized ability?—p. 357.

V 11 Do you believe that the National Electric Light Association could advance the interests of its members by establishing an exchange of advertising literature? If so, what practical plan can you suggest to carry out this idea?—p. 359.

V 12 Is there any objection upon the part of lighting companies to using cuts or advertising that have proven successful with other companies?—p. 361.

V 13 Can not a syndicate electric bulletin be employed by central stations to advantage?—p. 362.

V 14 What is the best method of advertising for (a) signs, (b) power, (c) store lighting, (d) residence lighting?—p. 363.

V 15 Should not a certain proportion of advertising matter issued be devoted to educating old customers to increased use of current?—p. 365.

V 16 In an advertising campaign, what should be the sequence between newspaper advertising, poster display advertising, street-car advertising, circularizing, "follow-up" letters, and the activities of the representatives of the commercial department?—p. 367.

*V 17 What class of advertising is considered most feasible for securing business, in addition to personal solicitation?—p. 368.

*V 18 How can the public be induced to regularly read the electric advertising, circular letters and newspaper advertisements? —p. 369.

V 19 What is the best means of getting local newspapers to print articles of general interest on electrical subjects, such as heating apparatus, new type of lamps, etc.?—p. 370.

V 20 Does newspaper advertising pay an electric light company? —p. 373.

V 21 How often should newspaper advertising copy be changed? —p. 374.

V 22 Is it better policy to take six-inch single newspaper column daily than a six-inch double column every other day?—p. 374.

V 23 Is it better in newspaper advertising to take a page, half-page or quarter-page weekly or semi-weekly than to spend the same amount of money per week in daily advertising?—p. 375.

V 24 Does advertising by means of souvenirs pay?—p. 376.

V 25 Does street-car advertising pay an electric light company? —p. 376.

V 26 Does advertising on paper billboards and painted display boards pay an electric light company?—p. 377.

V 27 Should street display advertising be scattered in paper posters in large quantities along street-car lines or should the same money be spent in permanent painted signs at transfer stations?—p. 378.

QUESTION

V 28 With a given appropriation available for poster display advertising, how can the money be spent to the best advantage in a city of 50,000 inhabitants or over?—p. 378.

V 29 Is it best to put a given sum of money into a large number of eight or sixteen-sheet paper posters scattered all over a city, or to put the same amount of money into comparatively few painted signs of a high standard in good localities?—p. 378.

V 30 How often should the design and reading matter of large, permanent painted signs be changed?—p. 379.

V 31 (a) Do pasters on customers' bills or enclosures with same pay? (b) Is it better to have these prepared to meet local conditions or to use those supplied by manufacturers?—p. 379.

V 32 Does advertising in theatre programmes pay an electric light company?—p. 380.

*V 33 Where a company controls both the electric light and gas business, how shall the soliciting department be handled to secure maximum increase of business in both departments?—p. 380.

*V 34 What is the best method of keeping records of new business prospects, such as solicitors may bring in daily?—p. 381.

*V 35 What is the best method of obtaining a check on work of solicitors?—p. 381.

*V 36 Should results obtained by solicitors be computed on number of applications or revenue secured?—p. 382.

*V 37 Is it advisable for a commercial department to offer a premium to the representative turning in the largest estimated revenue for a given period, and to what extent should this be carried?—p. 383.

*V 38 Have specialty salesmen such as power or sign experts proven a success?—p. 383.

*V 39 What is the best method of educating solicitors and representatives?—p. 384.

V 40 What means have been found advantageous for displacing gas engines and in their stead installing electric power? How about disposing of the gas engines?—p. 384.

*V 41 What inducements should be made in the way of free wiring where electricity is used for power purposes?—p. 384.

V 42 What is the best method of securing the most extensive use of desk fans?—p. 385.

*V 43 What is the best method of securing new business in higher class residence districts?—p. 386.

V 44 How can sign business best be developed?—p. 386.

V 45 Will flat rates assist in developing sign business? If so, how should the signs be controlled?—p. 387.

V 46 How can free signs be made profitable if each sign is special? —p. 387.

V 47 In fighting municipal ownership, should publicity methods be used as a counter attack?—p. 387.

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V 48 What percentage of gross receipts should be used for advertising in a city of 10,000 or 12,000 inhabitants?—p. 389.

V 49 Eliminating the value of advertising in the daily newspapers from a standpoint of "good policy," does the money spent in this manner bring as direct or as remunerative a result as the same amount of money spent in a "follow-up" system of novelty mailing cards, circular letters, etc.?—p. 392.

V 50 Is newspaper advertising more resultful when used to supplement "follow-up" advertising or when used as the only method of advertising?—p. 393.

V 51 Is it good policy for distributing companies to furnish electric signs? If so, under what conditions, as regards construction, erection, maintenance and method of charge—*i. e.*, meter or flat rate?—p. 393.

W

CONTRACTS AND RATES

W 1 In event of competition arising, is it better to make long-term contracts, or do business on the basis of orders without any definite term?—p. 394.

W 2 Is not a very short form of contract for electric service to general customers just as satisfactory as one with all possible conditions mentioned?—p. 395.

W 3 Is it advisable to make it a practice not to make a nominal minimum monthly guarantee on contracts for electric service?—p. 396.

*W 4 What are the best dozen papers on the rate question that have appeared in the electric journals or association proceedings?—p. 397.

W 5 What system of rates is being adopted by central stations for selling current for lighting purposes?—p. 398.

W 6 Will the demand system of rating prove practical for plants in cities of 15,000 to 25,000 population?—p. 399.

W 7 Are flat rates a disadvantage under all circumstances?—p. 400.

W 8 Is it necessary to use lock switches on electric signs, on flat rates, turned on and off by company's patrolmen?—p. 402.

W 9 Is it possible to develop a rate system that will charge every customer prices proportional to the costs individually and collectively incurred, within an error of ten per cent?—p. 402.

W 10 Assuming that all charges for electrical service can be made in direct proportion to costs individually and collectively incurred, is it wise and best for the community so to charge if by so doing output is restricted and the average price is held above what could be attained if individual charges were so adjusted as to least restrict use or consumption, and yet in the aggregate properly balance the books?—p. 403.

W 11 (a) What are the objections to a two-rate schedule by which a charge is made for a certain number of hours' use per day or per month of a customer's equipment, and a lower charge for the excess? How may they be overcome? Should such a schedule be different for power service from that adopted for lighting service? (b) It being understood that the higher charge is occasioned by the "fixed charges" of your plant, how may these fixed charges be determined per kilowatt-hour, and how may the number of hours per day to be charged at the high rate be determined? (c) Should not the lower charge be based strictly on the operating charges per kilowatt-hour sold? And would the lower charge be decreased for very high average daily use?—p. 404.

W 12 (a) What should be considered in fixing the amount of the maximum monthly charge per customer—anything besides interest on meter and connections, cost of reading and maintaining meter, and core loss if alternating current is used? (b) Is a minimum charge just and fair if it is any greater than the amount of these items? (c) If a minimum charge is made to customers supplied from separate transformers, is it made to those supplied from a 'bus line?—p. 407.

W 13 What objection, if any, is there to a system of rates somewhat as follows and what are its advantages: For general service, ten cents a kilowatt-hour. For a guaranteed average use of four hours daily per lamp, eight cents a kilowatt-hour; ditto five hours, seven cents; ditto six hours, six cents; ditto eight hours, five cents; with the guaranteed amount of kilowatt-hours monthly specified in the contract, as based on the particular installation? Power and light to be reckoned on the same basis of 16-cp equivalents. The customer to make a contract on one or the other of these bases.—p. 408.

W 14 Under what circumstances is a rate of (a) ten cents per kilowatt-hour, including free lamps and renewals, justified for commercial service? (b) Five cents? (c) Three cents?—p. 409.

W 15 What would be a fair price for lamps per year under the following conditions: Two hundred 16-cp lamps on moonlight midnight schedule, coal $4.50 per ton. Lamps in multiple through transformers supplying twelve lamps each?—p. 409.

W 16 If you furnish Nernst lamps and renewals free, what is your average price per kilowatt-hour sold to customers using the lamps, and what is your base or gross price?—p. 409.

W 17 What method do you adopt in connection with contracts made on a long-hour rate schedule to protect the supply company from too low rates, caused by customers installing more lights? —p. 410.

W 18 (a) Under what circumstances do you consider it wise to quote lower rates than are specified in your regular printed form of contract? (b) Is a reduced rate to large or "wholesale" cus-

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tomers, in the shape of a special printed or fixed schedule, justifiable? (c) If so, how may the wholesale rate be properly determined, and what should be the conditions under which it would be applied?—p. 411.

W 19 As most power customers use services at the time of peak load, and hence share in the fixed charges, why is it fair to charge any other rate schedule for power than for lighting, the cost of lamps and renewals being excluded, and it being understood that your rate schedule takes account of the number of hours average daily use?—p. 412.

W 20 Do you sell current for fans at flat rates during the summer months, or at meter rates? Do you make special fan contracts, or otherwise encourage fan business, and with what success? —p. 413.

W 21 Have you had special success with any plan of encouraging off-peak business, such as making special contracts to shut down steam and electric plants during summer months? What is your policy in such cases?—p. 414.

W 22 What is the best term to use in defining candle-power or size of lamps to be furnished under municipal contracts?—p. 415.

W 23 On what terms should service be supplied to employees in their actual homes?—p. 416.

W 24 What is the lowest rate for power charged by members to consumers of average of 2000 to 3000 kilowatt-hours per month? —p. 417.

W 25 On series arc systems, contract, all expenses and risk considered, why is the rate per kilowatt-hour so much lower than the same service, metered, on the multiple system?—p. 417.

W 26 Have central stations adopted special rates for electric-sign advertising? If so, why? Does this rate vary, and on what basis?—p. 418.

W 27 Has any effort been made to induce national advertisers to use electricity for advertising purposes? Why not make a uniform fixed rate for this class of advertising, which would apply to cities and towns of like class, so that these advertisers could include electric advertising in their appropriation the same as newspaper, bill posting and painted-sign work?—p. 419.

X

Accounting and Statistics

X 1 (a) In a city of the first class, which has been fairly well canvassed, may it be expected that the new business now obtained will average as many lamp equivalents per customer as formerly, and that each customer will bring in as much revenue per lamp equivalent? (b) What is the average number of lamp equivalents per customer, and the average revenue per lamp equivalent?—p. 419.

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X 2 What rate of increase in 16-cp equivalents of connected installations may fairly be expected from year to year in cities of the first class?—p. 419.

X 3 What rate of increase in gross income from current sales, from year to year, may fairly be expected in cities of the first class? —p. 420.

X 4 What percentage of yearly increase may fairly be expected in the total horse-power of motors in connected installations? How much horse-power have you now connected?—p. 420.

X 5 (a) How many companies in this country exceeded 125,000 16-cp equivalents increase in connected installation in 1905? (b) What was your increase last year, and the population of the territory served?—p. 420.

X 6 What is your total canvassing and advertising expense per week per incandescent lamp equivalent added to your supply system? —p. 420.

X 7 What is the amount of population in your territory to each solicitor or canvasser? How many customers do you have to each solicitor?—p. 420.

X 8 What is the average number of 16-cp lamp equivalents of new business obtained per year for each solicitor or canvasser? —p. 420.

X 9 For a city of the first class, what is a fair average income from the sale of current per kilowatt-hour billed for commercial service, light and power? How is six cents?—p. 420.

X 10 What is the best method of keeping the accounts of mixed flat-rate and meter customers?—p. 421.

X 11 Should ledger be written up according to meter reader's route or alphabetical order of streets?—p. 422.

X 12 When lighting accounts are billed at a net rate, what means can be suggested to insure or induce prompt payments?—p. 423.

X 13 Have you used the Hollerith system of tabulating and summarizing earnings, and with what success?—p. 424.

X 14 What is the proper method or custom, in case of an established light and power plant, in making the books correct to show the true relation between capital account and net income?—p. 426.

X 15 Has the depreciation charge on the various classes of apparatus making up the complete equipment of electric companies been standardized?—p. 427.

X 16 In charging depreciation on electric plants, what is the best method of arriving at the correct amount charged? Should the amount be a percentage or should it be a percentage of the structural value, and, if so, how arrived at?—p. 428.

X 17 Is it correct in substituting new equipment for old, either worn out or inefficient, to charge the new equipment against capital account when the change is in the nature of repairs or for more efficient machinery?—p. 428.

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X 18 What percentage of the gross income of an electric light company should with propriety be spent on analytical and statistical work in order that the business may be thoroughly known in each and all of its details rather than lumped in under the usual general headings; as, for instance, Expenses up to the Switchboard, Distribution Expenses, Management Expenses, etc.?—p. 429.

*X 19 What is being done toward obtaining a uniform and accurate system of classification of accounts?—p. 429.

*X 20 What is best, cheapest and most up-to-rate method of keeping stores?—p. 429.

*X 21 In keeping stock is it best to give each class of articles a serial number to be used instead of name, similar to systems used by railroads? Give reasons.—p. 430.

X 22 In a large electric light company, is it sufficient to carry the operating accounts and other accounts forward month by month with simply the detailed items of expenses and fixed charges, or does it pay to carry also a supplementary analytical statement, developed under the headings of the various major functions governing the business; as, for instance, Output Costs, Customer Costs, Demand Costs, Reserve Capacity Costs, etc.?—p. 430.

X 23 What is the ratio in your plant between the kilowatts of maximum peak load and the kilowatts of total connected installations?—p. 430.

X 24 What is the load factor in your plant on the day of maximum peak winter load; that is, the ratio between kilowatts at the time of maximum load and average kilowatts?—p. 431.

X 25 Taking as a basis your maximum peak load in kilowatts and your annual station output in kilowatt-hours, what is the equivalent number of hours' use per year of your maximum load?—p. 431.

X 26 What is the ratio in your plant between the peak load in kilowatts on the week of smallest average peak load and the week of heaviest average peak load; that is, comparing your summer and winter loads?—p. 431.

X 27 What is the ratio in your plant between the kilowatt-hours during the week of smallest station output and the week of largest station output; that is, comparing your summer and winter loads?—p. 432.

X 28 What is the ratio in your plant between the total kilowatts of meter capacity and the total installation or maximum load—eliminating, of course, that part of the installation or maximum load that is not supplied on a meter basis?—p. 432.

X 29 In a plant with a monthly output of 200,000 kilowatt-hours, what percentage of this current should be lost, including current stolen and unaccounted for, under the following conditions?

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63,800 kilowatt-hours of the above total is the output, measured on the alternating-current end of a rotary converter, changing from 2300 volts alternating current to 500 volts direct current. Primary voltage, 2300; secondary voltage, 110; 700 induction meters of the latest type; 600 T. R. W. commutator-type meters; 190 G. E. transformers, ranging from 6 to 15 kilowatts; no secondary or primary wire smaller than No. 8, and the copper as a whole not loaded beyond its carrying capacity; 208 G. E. series street arcs, nominal 2000-cp operated by means of three tub transformers; the output of the rotary above mentioned, for motors exclusively; no alternating-current motors. —p. 432.

X 30 What is the average percentage of lamps lost per year to lamps gained among the larger companies? In other words, to every 100 lamps connected how many are disconnected? —p. 433.

X 31 In a city with population of 70,000 and no gas competition, what would be considered good results as to total connected lighting load per capita expressed in 16-cp equivalent?—p. 433.

X 32 What methods are in use for systematically and regularly ascertaining the various distribution losses?—p. 433.

X 33 Where companies operate both lighting and railway departments from the same central station, what is the usual method pursued in arriving at the operating expenses of each? That is, does each department have its individual operating accounts, or does one department bear all the expenses and charge the other department by the kilowatt-hour at the switchboard?—p. 434.

X 34 On a system operating several water-power and steam plants, all connected to the same transmission line, steam plants being run over the peak load only, what is the best method of arriving at the cost per kilowatt-hour water-power as against steam? In connection with this it must be borne in mind that fires are kept up under boilers of the several steam plants for emergency purposes, and a sufficient number of men kept on duty continually to operate the steam plants in case of breakdown anywhere on the line. There is a certain amount of fuel and labor expended, which is neither actual steam operation nor water-power, but simply insurance in case of accident. In addition to this, there is certain attendance on transmission stations all along the line, and current may go into these stations from water-power or steam sources.—p. 435.

X 35 What is considered the maximum percentage of operating expenses to income at which a medium-sized electric light plant can show a fair return on the investment?—p. 436.

X 36 Give good form for meter cards and customers' index, for use in small stations.—p. 436.

Y

MANAGEMENT

QUESTION

Y 1 What are the managers in small towns doing to compete with the gasolene proposition?—p. 438.

*Y 2 How small a town will justify the building of an electric light plant?—p. 438.

Y 3 What conditions should be taken into account in determining if a day load would pay in towns of from 2000 to 10,000 population? Also, what conditions should govern the price of current for power to be sold to several large consumers in order to assist day load?—p. 439.

Y 4 On what sized plants in cities of from 2000 to 10,000 is it better to install meters in preference to flat rates?—p. 440.

Y 5 Should the management of an electric light company be conducted with the same economy that it should insist upon in every other department, or should it be conducted on the lines that will give the greatest use of current by the community, minimum average price, maximum gross and net earnings and highest general efficiency, practically without regard to the specific costs of management, except that they produce the results suggested?—p. 441.

Y 6 In small companies, where the station and line force consists of not more than ten or twelve men all told, is it advisable to attempt any rotation of duties for the employees, in order to familiarize them with one another's work, as a precautionary measure in case of emergency?—p. 441.

*Y 7 Would it be advantageous to establish free night schools for the employees in the manufacturing and distribution departments, to furnish a course of instruction pertaining to these departments?—p. 443.

Y 8 Should either the operating or commercial departments of an electric company desirous of increasing its motor business have all consumers' apparatus, shafting and machinery inspected and tested periodically by an expert so as to reduce waste, and in this manner get in closer touch with consumers and insure their continued patronage?—p. 443.

*Y 9 Is it not desirable to have application and complaint departments as part of the commercial department, or handled by men trained in the commercial department, because of their familiarity in dealing with the public?—p. 444.

*Y 10 What method should be used with consumers who are chronic kickers—people who come to the office every month with a complaint?—p. 445.

*Y 11 When the office force at the complaint desk knows nothing about the circumstances, what is the best and most satisfactory way of handling complaints in regard to high bills?—p. 447.

Question

*Y 12 What is being done to convince people of the company's proper relation to the public? Will publicity be of advantage in this connection, and what will be of the greatest value in convincing the public that they are getting full value for what they are paying?—p. 447.

*Y 13 Has the granting of a percentage of their gross earnings by many companies throughout the country to their respective cities had a tendency to subdue municipal ownership agitation? —p. 449.

*Y 14 What is the proper basis for taxation and how shall it be reckoned? What is the practice in your company and state, and if inequitable, why is it so?—p. 450.

Y 15 Under what circumstances do you consider small two-story residences as desirable customers?—p. 450.

Y 16 What has been the best plan for closing down isolated plants in large cities where steam is required to heat buildings? —p. 451.

Y 17 Supposing a competing company establishes a supply system generally through your territory, what is the best policy to pursue in handling your existing business and the competition generally?—p. 451.

Y 18 Is it good policy to rather encourage installation of a very limited amount of gas in electrically-lighted stores, churches, etc., giving consumer a chance in event of failure of part or all lights at a critical time?—p. 452.

Y 19 How can a company protect itself from loss in case of the death or failure of the free-sign customer?—p. 453.

Y 20 What is the best method of paying solicitors?—p. 453.

Y 21 Can a display department be made to pay by adding a percentage to articles sold?—p. 454.

Y 22 Where can complete data be obtained on special appliances which can be used on lighting circuits?—p. 455.

Y 23 Is free wiring, where necessary to secure public building lighting, warranted as an advertisement when the company does not do any wiring?—p. 455.

Y 24 Does it pay a lighting company to do interior wiring where there are no competing electrical contractors?—p. 455.

Y 25 How far should a company go in assisting contractors?—p. 456.

Y 26 Should lighting companies sell motors or fans in towns where by so doing they antagonize electrical contractors?—p. 456.

Y 27 If a lighting company sells fans and motors, should the price be kept up so that contractors can compete?—p. 458.

Y 28 Does it pay a lighting company to sell portables and fixtures? —p. 459.

Y 29 What is a fair average number of meter readings per man per day?—p. 460.

Y 30 Who has charge of the meter readings? Do your meter readers report to the accounting department, to the office, to the meter department, or to the superintendent of distribution? —p. 461.

Y 31 In a city using single-phase alternating current for lighting, is multiphase alternating current or 500-volt direct current preferable for power circuit within one mile of plant?—p. 463.

Y 32 Has experience with single-phase motors in sizes up to 25 horsepower shown them to be as generally satisfactory as multiphase motors?—p. 464.

Y 33 What amount of investment per kilowatt is a central station warranted in making in translating devices, such as lamps? —p. 465.

Y 34 (a) What practices or systems are in vogue in plants not large enough to afford the expense of a night inspector or trouble man? (b) Do you believe in offering extra compensation to any one employee to take care of complaints that come in after 5.30 p. m.?—p. 465.

Y 35 What analytical method is employed by the managements of large substation systems in fixing scales of wages of substation operators? I refer to those systems which include a great number of substations, each of a different grade, both in regard to extent of development and importance in the territory; also including operators of various grades in each substation.—p. 466.

Y 36 On what results obtained by solicitors should commission be based?—p. 466.

Y 37 (a) What is being done by the various corporations operating electric, or compound gas and electric, properties toward a concise and uniform set of rules and instructions to station, distribution and other employees? Into how much detail do you consider it necessary to go in instructions of this kind? (b) What bearing on damage suit would the prior enforcement of such a set of rules and instructions have? (c) Do you find that the enforcement of such a set of rules and instructions tends to make employees more careful and to get a better class of work from them?—p. 466.

Y 38 What has been the experience of the management of large substation systems concerning the advisability of encouraging the organization of social or other clubs among their substation employees?—p. 466.

Y 39 Do the majority of electric light companies carry accident insurance to cover both the public and employees?—p. 467.

Y 40 Six parties are usually interested in having the Underwriters' certificate covering the electric equipment of a building properly issued—the underwriters, owner, tenant, wiring contractor, fixture contractor and the lighting company. State what duties, in your opinion, each party should take upon itself in securing the certificate. State actual present usage in connection with matter.—p. 467.

Y 41 What can be done to meet isolated-plant competition?—p. 468.

Y 42 In a city where there are a great many transient customers, what can be done to prevent the customers from moving between meter readings without notifying the company, in this way beating their bills for a portion of a month?—p. 471.

Y 43 In a large city divided into districts, is it advisable to have complaints adjusted by each district office, or should they be handled from the main office, and why?—p. 472.

Y 44 How do companies average bills when the registration of meter is high or low?—p. 473.

Y 45 Should the contracting or the auditing department decide upon the credit of a prospective customer?—p. 473.

Y 46 Up to what distance would it be more profitable to locate a plant at the mines than at the centre of distribution? Maximum to be distributed, 15,000 kilowatts; load factor, 30 per cent; freight on coal, half a cent per ton per mile; 4.5 pounds of coal per kilowatt-hour.—p. 474.

Z

LEGAL

Z 1 Under what conditions may a right-of-way for poles, lines and wires be made permanent, unless a consideration is made to especially cover its permanency?—p. 474.

Z 2 We are changing from 220-volt direct-current 3-wire distribution to 2200-volt alternating current. The local telephone company raises objection on account of danger. Has this objection any valid legal basis?—p. 475.

Z 3 Is there a state law, written or implied, requiring 2300-volt lines to be placed at certain distances from telephone, or other wires? If so, at what distance?—p. 476.

Z 4 Assuming an underground conduit system has been installed by an electric light company in compliance with franchise and municipal ordinance, should the company or the city bear the expense of moving, altering or repairing the conduit system in case such becomes necessary to accommodate new or additional water mains, sewers, drains, etc., belonging to and installed by the city? Can you give records of legal decisions bearing on this or similar cases?—p. 477.

Z 5 Has the judiciary body of a state the right to fix rates?—p. 478.

Z 6 Has the legislative body of a state the right to fix rates?—p. 478.

Z 7 Have municipal authorities any legal standing in making or regulating the rates of public-service corporations in their municipalities?—p. 478.

Z 8 Has a public body, judicial or legislative, which has the power of

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rate making, the right to fix rates on the aggregate or mass—for the whole community—amounts and averages, always, of course, under the Federal restrictions—or must it allow all individual costs in so far as these are individually determinable?—p. 479.

Z 9 Assuming that local charges must be individually differentiated in proportion to individual costs, in so far as these are determinable, and that individual costs are individually determinable, say to the extent of 60 per cent of the total legitimate costs, how does the law say that the remaining 40 per cent of legitimate costs, which are assumed to be individually indeterminable, shall be assessed?—p. 479.

Z 10 Within what Federal restrictions must state authorities act in rate making or regulation?—p. 480.

Z 11 Has the legality of the fixed minimum charge been passed upon by the courts? What was the outcome, and where can the records of the case or cases be found?—p. 480.

Z 12 A damage suit has been brought against a company where a banker went into a bank, took hold of an electric light bulb with one hand and the safe door with the other and was killed. Have you any record of any case where a person was killed with 110 volts?—p. 481.

Z 13 A company has been sued by the widow of a former customer for $10,000 damages on account of the husband receiving a shock from a combination swinging bracket in the bath-room of his residence, which, in connection with heart disease, caused death. What information can you furnish as to decisions in cases of like nature heretofore tried?—p. 482.

Z 14 Assuming a broken telephone wire cuts through the insulation (triple-braid, weatherproof, previously in good condition) of an electric light wire carrying a 2200-volt current, and causes the death of a person coming in contact with the telephone wire, is the owner of the electric light wire legally responsible?—p. 484.

Z 15 Has liability insurance, either employers' or public, paid the company, or is the amount of losses much less than the premium?—p. 486.

Z 16 Is the electric lighting company required by law to supply service to consumer with whom it does not care to do business by reason of consumer's unwarranted complaints, accusations of dishonesty, and so forth?—p. 487.

Z 17 Could a consumer lawfully refuse to allow this company to remove wiring that had been placed on installment plan, in the event of non-payment or other cause?—p. 488.

Z 18 A company has 500-volt direct-current and 110-volt alternating-current mains all over the city. In order to improve the service and cut down operating expenses, the company wishes to do away gradually with its 500-volt business. Can it refuse to connect a man who demands 500-volt current?—p. 488.

Z 19 Hadn't the public-service corporations better "come down the pole" and admit gracefully that the people have the right to fix reasonable rates, where prevailing rates are proven by proper examination to be unreasonable?—p. 489.

UNCLASSIFIED

1 How can the medical profession be awakened to the necessity of attempting to revive persons shocked into insensibility? The writer has had two unhappy experiences with doctors who grew indignant because their ability to discern between life and death seemed to be questioned.—p. 489.

2 Is there any electro-chemical process the product of which could be manufactured on a profitable basis by electric lighting companies, utilizing for this purpose the spare capacity available at low-load hours?—p. 490.

3 Could a practical wind-power plant of moderate cost be designed for electric lighting on farms in the prairie states, where winds are nearly as continuous as on the ocean beach?—p. 490.

4 What improvement in the *Question Box* can you suggest? —p. 491.

5 Is there a watch permanently immune from irregularities due to stray fields?—p. 493.

INDEX—III

GENERAL INDEX

NOTE— + indicates " Unclassified.'

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C

Cagney J. J., The Montreal Lt., Ht. and Pr. Co., Montreal, Canada.
S 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17. U 2, 6, 7, 8, 9, 11, 12, 14, 15, 16. V 3, 4, 6, 10, 11, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 42, 47. W 1, 2, 3, 7, 19, 20. Y 5, 9, 10, 12, 13, 27, 30. Z 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13, 15.
Cambridge Elec. Lt. Co., Cambridge, Mass.
T 21.
Campbell, Alex J., Gen. Mgr. New London Gas and Elec. Co., New London, Conn.
D 15. P 2, 17, 21. S 2, 3, 5, 6. W 19, 22. X 15. Y 4, 6. Unc. 4.
Century Elec. Co., St. Louis, Mo.
T 12, 15.
Chasteney, C. D., DeLaval Steam Turbine Co., Trenton, N. J.
I 1, 3.
Clark, E. C., Chicago Edison Co., Chicago, Ill.
G 3. Y 32.
Clark, Wallace S., General Elec. Co., Schenectady, N. Y.
Q 11.
Codman, J. S., J. S. Codman and Co., Boston, Mass.
R 15. S 12. W 4, 5, 6, 7, 9, 10, 11, 17, 18, 19.
Collins, C. C., Ass't Gen. Supt. The Columbus Ry. and Lt. Co., Columbus, Ohio.
T 21.
Colorado Springs Elec. Co., The, Colorado Springs, Colo.
A 4, 7. M 1, 2, 5. P 1, 2, 8, 10, 12, 13, 16, 17, 20, 23, 24. R 1, 4, 6, 7. S 22. T 9. U 7, 8, 9, 10, 12, 13, 23, 24, 27, 31, 32.
Comstock, Charles W., Consulting Engr., Boston Bldg., Denver, Colo.
A 2, 3, 5. B 7, 8. C 1, 2. D 1. F 3, 4. K 2. P 4, 5.
Cox, J. R., Mgr. Brush Elec. Lt. and Pr. Co., Galveston, Texas.
D 1, 16. M 2, 5. P 1, 10. S 31.
Crawford, L. R., Supt. Sioux City Service Co., Sioux City, Iowa.
J 2, 4.
Cushing, S. B., Chicago, Ill.
W 3, 7, 22.
Cushman, G. H., San Antonio Gas and Elec. Co., San Antonio, Texas.
S 6, 26, 30. T 9. U 31, 32. X 11. Y 30, 31.

D

Davis, Ernest H., Lycoming Elec. Co., Williamsport, Pa.
Z 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15.
Deal, E. C., Supt. Public Service Corp. of N. J., Hackensack, N. J.
P 8, 10, 13, 14, 16, 20, 30, 32, 33, 38, 39, 40, 41, 44, 47, 48, 49 R 8, 15. S 5, 13. U 7, 11, 12, 13, 14, 15, 24, 26, 31, 34, 36.

Denman, B. J., Engr. Peninsular Elec. Lt. Co., Detroit, Mich.
B 6. D 1, 3, 4. E 3, 8, 9. G 1. H 1. J 1, 4. M 1, 2. O 2. P 10, 21, 23. R 1. T 1, 5. U 5. W 3, 5, 6, 7, 11, 13, 21. Y 15, 16, 18.

E

Ebensburg Lt., Ht. and Pr. Co., Ebensburg, Pa.
Z 14.
Eddy, H. C., Distr. Mgr. American District Steam Co., Chicago, Ill.
J 5, 6, 7, 8.
Edison Elec. Ill'g Co. of West Chester, The, West Chester, Pa.
F 3, 4. G 1. K 1, 5. O 8, 9. P 50. R 7, 12. S 1, 2, 3, 5, 6, 7, 8, 9, 10.
Edwards, H. M., Auditor The New York Edison Co., New York City.
X 13.
E. L., Chicago Edison Co., Chicago, Ill.
L 1, 2, 3, 4.
Elden, L. L., Elec. Engr. The Edison Elec. Ill'g Co. of Boston, Boston, Mass.
A 7. K 5. L 1, 2, 4. M 1, 2, 4, 5. P 1, 2, 10, 12, 13, 14, 16, 17, 20, 21, 22, 24, 25. Q 1, 3, 4, 5, 10. R 1, 8, 10, 11, 12, 13, 15, 17. X 23, 24, 25, 27. Y 31, 32.
Emerick, L. W., Fulton Lt., Ht. and Pr. Co., Fulton, N. Y.
B 14. S 1, 2, 3, 4, 6, 12, 26. U 6. V 11, 21, 23.
Emmet, W. L. R., General Elec. Co., Schenectady, N. Y.
I 2, 3, 7, 8, 9, 10.
Enright, J. H., Mgr. Frederick Gas and Elec. Co., Frederick, Md.
S 13. U 2, 4, 6, 7, 12. V 33. Y 6, 11, 26, 27.

F

Farrand, Dudley, Public Service Corp. of N. J., Newark, N. J.
E 1. G 2. O 5, 6, 7. Q 9. R 9. S 11. Y 19, 22, 23, 25.
F. C. S., Malden Elec. Co., Malden, Mass.
A 7. K 4. M 1, 3, 4, 5. P 1, 2, 4, 5, 10, 11, 13, 16, 17, 20, 23, 24. R 1, 2, 5, 7, 15, 17. S 3, 5, 13, 15, 18, 29, 31. T 1, 2, 9. U 1, 2, 4, 6, 7, 10, 11, 13, 14. V 11, 12, 20. W 7, 20, 22. X 11. Y 4, 6, 7, 8, 26, 27, 28, 29, 30, 31, 32. Z 14.
Fellows, W. H., Supt. Leavenworth Lt. and Htg. Co., Leavenworth, Kan.
D 3, 4, 16. K 7. P 10, 11, 13, 16, 21. R 1, 7, 17. S 22, 23, 26, 27. T 9. U 5, 7, 8, 11, 12, 13.
Ferry, D. J., Public Service Corp of N. J., Metuchen, N. J.
E 18, 20. G 3, 5, 6, 9. I 9.
Field, H. T., Elec. Engr. American Electrical Works, Phillipsdale, R. I.
Q 11.
Flint, Walter, The Jacob Tome Inst., Port Deposit, Md.
A 8, 9. B 12. G 5, 6. H 8. J 6. N 2. S 37. U 26.
Foster, S. C., Fredericksburg, Va.
G 9.

Francis, F. S., The Bell Telephone Co. of Philadelphia, Philadelphia, Pa.
P 3, 4, 5, 6, 17, 18, 21, 30, 31.

French, E. R., Supt. United Elec. Co. of N. J., Elizabeth, N. J.
P 2, 13, 21, 23. R 1, 6, 7. S 1, 2, 3, 4, 5, 6, 7, 10, 15, 26, 28. T 1, 2, 4, 5. U 7, 8, 9, 11, 12, 14.

Fretz, A. O., Supt. Doylestown Elec. Co., Doylestown, Pa.
A 7. L 1. P 16. S 4, 5, 8, 23. U 8, 16. Y 4, 6, 24.

Frueauff, Frank W., Vice-Pres. and Gen. Mgr. The Denver Gas and Elec. Co., Denver, Colo.
W 1, 2, 3, 7, 9, 10, 13, 17, 20. X 1, 11, 13. Y 29, 30.

Fuller, W. W., C. C. Ry., Gas and Elec. Co., Charleston, S. C.
A 7. D 3, 4. F 3. H 14. M 1, 2, 5. O 5. P 3, 4, 10, 11, 13. R 1. S 1, 3, 14, 15, 17, 22, U 14, V 12. W 20. Y 4, 6, 7, 18, 24, 27, 29, 30, 31. Z 12.

Fulton, A. G., Holt Lumber Co., Oconto, Wis.
S 18.

G

Gaffney, J. J., Supt. Public Service Corp. of New Jersey, Newark, N. J.
M 2. P 13, 16. Q 3. R 1. S 1, 2, 3, 4, 6, 13, 22, 23. T 21. U 7, 8, 9, 11. Y 29, 30.

Gardiner, W. H., Jr., Boston, Mass.
V 1, 4, 7, 11, 12, 13, 15, 17, 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 36, 38, 43, 47. W 1, 2, 3, 5, 6, 7, 9, 10, 18, 19. Y 6, 7, 8, 9, 10, 12, 13, 24.

Gartland, C. C., Sioux City Gas and Elec. Co., Sioux City, Iowa.
C 3. D 1. E 4. F 4. H 4. L 2. O 3. P 6, 16. R 3. S 28. T 9. U 13. V 3.

Gear, H. B., Chicago Edison Co., Chicago, Ill.
P 10, 13, 21, 26, 44. Q 14. R 6, 8, 10, 12, 28.

Geiger, Clayton F., Wilmington City Elec. Co., Wilmington, Del.
K 1. L 2. P 44. R 25.

Gilmour, L. D. H., Public Service Corp. of N. J., Newark, N. J.
Z 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19.

Gould, P. A., Treas. Saranac Lake Lt., Ht. and Pr. Co., Saranac Lake, N. Y.
W 6, 17.

Gray, Thomas, Mgr. Honk Falls Pr. Co., Ellenville, N. Y.
B 3, 7, 8. P 19. R 3.

Greene, L. W., The Brooklyn Elec. Lt. Plant, Brooklyn, Mich.
A 8, 9. C 3, 4. E 2, 14. G 14. H 7, 12, 14. N 2. P 16. R 7, 29. S 2, 3, 4, 15, 17, 22. W 7. Y 4.

Greene, W. J., Cedar Rapids and Iowa Ry. and Lt. Co., Cedar Rapids, Iowa.
J 2, 4. K 7.

Greenslit, W. H., Elec. Engr. Vicksburg Ry. and Lt. Co., Vicksburg, Miss.
K 3, 5. M 1, 3, 4. P 13, 14. R 1, 8, 15, 17. U 6, 7, 8, 9, 10, 12, 16.

H

Hadfield, R. H., Chicago Edison Co., Chicago, Ill.
D 12, 14. F 4. J 1, 2. O 9.
Hale, R. S., The Edison Elec. Ill'g Co. of Boston, Boston, Mass.
W 17.
Hall, Andrew F., Southbridge Gas and Elec. Co., Southbridge, Mass.
F 3, 4. H 2. P 16, 17. R 7. S 1, 3, 4, 6, 7, 9, 10, 15, 17, 22, 23, 25.
Hammond, John Craig, New York City.
V 1, 2, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 31, 34, 37, 39, 44, 47.
Hartman, H. T., Second Vice-Pres. Elec. Co. of America, Philadelphia, Pa.
A 1. D 1, 5, 7, 12, 13, 22. E 4, 5, 6, 7, 9. F 3, 4. I 8, 10. J 1.
Henderson, V. A., The Denver Gas and Elec. Co., Denver, Colo.
X 13.
Herschel, Clemens, Civil and Hydraulic Engr., New York City.
B 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.
Hewlett, E. M., General Elec. Co., Schenectady, N. Y.
M 13, 16, 17.
Higgins, C. W., Duluth General Elec. Co., Duluth, Minn.
K 3, 4, 6, 7. M 5, 6. R 14. X 24, 25, 26, 27. Y 6.
Hodge, Carroll, The Electric Storage Battery Co., Philadelphia, Pa.
L 12, 13.
Hodges, W. H., Secy. Thomson Elec. Welding Co., Lynn, Mass.
T 21.
Hodgkinson, Francis, Westinghouse Machine Co., East Pittsburgh, Pa.
I 3, 19, 21, 25, 27.
House, G. O., Secy. Northern Mfg. Co., St. Paul, Minn.
J 3.
Hutchins, B. W., Bradford Elec. and Pr. Co., Bradford, Vt.
B 3.
H. W. DeV., Westchester Ltg. Co., Mount Vernon, N. Y.
F 4. G 1. K 3.

I

Inch, S. R., Missoula Lt. and Wtr. Co., Missoula, Mont.
B 5. C 7. L 5. M 3. R 10. X 26, 27, 28, 29, 32. Z 15.
Ingalls, Percy, Public Service Corp. of N. J., Newark, N. J.
S 1, 2, 3, 4, 5, 6, 10, 12, 13. T 1, 2, 5. U 2, 3, 4, 6, 14, 16. V 3.
Ingman, S. S., Florence, S. C.
D 4. H 1, 3, 5. P 3, 13, 20, 21, 23. S 2, 12, 14. U 2, 5, 6, 7, 13, 14, 15.
Inman, C. E., Supt. The Warren Wtr. and Lt. Co., Warren, Ohio.
S 1, 2, 3, 4, 6, 13. U 7, 10, 11, 12, 21, 23, 30, 31, 32, 36.
I. O., Westchester Ltg. Co., Mount Vernon, N. Y.
A 2, 3, 4, 7.

J

Jackson, Dugald C., Prof. Elec. Eng. University of Wisconsin, Madison, Wis.
D 10. E 3, 12. F 6. G 13. K 4, 21. M 9, 14. N 3. O 11. P 4, 26, 30, 37. R 21. Y 40. Unc. 5.
Jackson, Wm. B., M. E., Consulting Engr., Madison, Wis.
A 2, 4, 7. E 4. F 4. G 6. K 5, 8, 22, 23, 27. M 1. P 8, 10, 15, 17, 41, 44. T 10.
Jamieson, B., Chicago Edison Co., Chicago, Ill.
E 4. Q 5.
Jennings, W. D., Westchester, N. Y.
S 17, 18, 19, 21, 22, 23, 26, 27, 30, 39, 40, 44,
Jewett, F. N., Wagner Elec. Mfg. Co., Chicago, Ill.
J 1, 4.
Johnson, F. A., F. L. Williamson and Co., Clay Centre, Kan.
B 3. M 9. N 2. P 31. U 7, 12, 13, 20, 23.
Johnson, H. B., Supt. The Decatur Lt., Pr. and Fuel Co., New Decatur, Ala.
C 2, 3, 4. G 1. H 2. I 4.
Junkersfeld, P., Chicago Edison Co., Chicago, Ill.
C 9. I 13. K 15, 20. L 8.
J. W. C., Edison Elec. Ill'g Co. of Boston, Boston, Mass.
S 1, 2, 3, 4, 5, 6, 7, 11, 13, 15, 16, 17, 18, 19, 22, 23, 24, 27, 28, 29, 31, 43, 44, 45, 46, 47. U 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 34.

K

Kahn, Samuel, Elec. Engr. San Antonio Gas and Elec. Co., San Antonio, Texas.
D 25. P 27, 44, 48.
Keller, C. A., Chicago Edison Co., Chicago, Ill.
P 15, 24.
Kelly, E. S., Pres. and Gen. Mgr. The Home Ltg., Pr. and Htg. Co., Springfield, Ohio.
J 2, 4.
Kemper, Ludwig, Treas. and Mgr. Albert Lea Lt. and Pr. Co., Albert Lea, Minn.
D 12, 13, 18. E 4. J 1. P 17, 23. S 1, 2, 5, 6, 7, 10, 13, 29. U 6. V 3, 20, 41. W 7, 20. Y 1, 4, 10, 12, 15, 20, 24, 28.
Kent, A. R., Chicago Edison Co., Chicago, Ill.
P 1, 2.
Kent, Wm., Syracuse University, Syracuse, N. Y.
D 1, 2, 9, 12, 14, 15, 18. E 6, 7, 8.
Kimball, R. N., Gen. Mgr. Kenosha Gas and Elec. Co., Kenosha, Wis.
D 9, 10, 13, 14, 23. E 2, 4, 9. J 1. P 17, 18. R 1, 2, 4, 7, 15. S 22. T 9. U 5, 6, 14. V 3, 12, 15, 19, 20, 23, 31, 33, 35, 36, 41. W 18. X 11, 15, 24. Y 20, 24, 26, 28.

Kinney, F. F., Chicago Edison Co., Chicago, Ill.
M 16.
Korst, P. H., Secy. and Mgr. Janesville Elec. Co., Janesville, Wis.
A 7, 9. B 3. P 33. T 5. V 7, 15, 48. W 21, 24, 26.

L

Lansingh, Van Rensselaer, Ill'g and Elec. Engr., New York City.
S 2, 3, 4, 5, 6, 27. Y 1, 15. Unc. 4.
Larrabee, H. D., Hoosick Falls Ill'g Co., Hoosick Falls, N. Y.
H 7, 8, 10. K 5, 9, 13, 14, 22, 23, 27. M 1. P 13, 32, 37, 38, 39. R 1, 21, 29. S 1, 37. T 6, 9, 11, 14. U 23, 24, 29, 30. W 24. Y 24, 28.
Laxton, Ralph R., Elec. Engr. Victor Mfg. Co. and Apalache Wtr. and Pr. Plant, Grears, S. C.
I 11, 12. K 13, 26. P 22, 24, 25, 26, 27, 28, 29, 30, 38, 39, 40, 41, 42, 44, 45, 48, 49. Q 4, 5. R 3, 6, 7, 8, 13, 14, 15, 19. S 9, 12, 21, 26, 31. T 9, 10, 11, 12, 13, 14. U 2, 6, 9, 13, 24, 25, 26, 27, 29, 32. V 3, 20, 31. W 1, 2, 19, 25. X 33, 34. Y 3, 4, 5, 6, 8, 9, 10, 11, 12, 15, 17, 18, 24, 26, 27, 30, 31, 32, 34, 40, 41, 42, 43, 45, 46. Z 1, 2, 3, 4, 5, 6, 8, 10, 12, 13, 14, 16, 17, 18, 19. Unc. 1.
Ledford, N. H., Bowling Green Elec. Lt. Plant, Bowling Green, Mo.
P 7, 10, 11, 13.
Lesley, Hugh, The Elec. Storage Battery Co., Philadelphia, Pa.
L 4, 5, 6, 11.
Lewis, J. S., Supt. Murphy Htg. Co., Detroit, Mich.
J 3.
Lincoln, P. M., Westinghouse Elec. and Mfg. Co., Pittsburgh, Pa.
A 7. K 4, 6. M 3.
Lindsay, Robert, Gen. Supt. The Cleveland Elec. Ill'g Co., Cleveland, Ohio.
T 21.
Lloyd, A. T., Shreveport Gas, Elec. Lt. and Pr. Co., Shreveport, La.
P 17, 21. R 1, 6. W 1. X 29.
Lukes, J. B., Gen. Supt. The Seattle Elec. Co., Seattle, Wash.
J 3. W 17.
Lüpke, Paul, Editor *Question Box*, Trenton, N. J.
D 1, 25. U 18, 19. W 22. Y 30. Unc. 3.

M

MacKinnon, A. R., Mgr. Cheboygan Elec. Lt. and Pr. Co., Cheboygan, Mich.
A 8. S 37.
Marsh, Converse D., The Bates Advertising Co., New York City.
V 48, 49, 50, 51.
Martin, T. C., Editor *Electrical World*, New York City.
Unc. 4.

Mather, E. H., Treas. and Mgr. Portland Ltg. and Pr. Co., Portland, Me.
B 7. E 4. M 1. P 9, 13, 17, 18, 19, 20, 21, 23, 24. R 1.
Maunsell, C. R., Edison Elec. Ill'g Co., Topeka, Kan.
J 2, 4.
McDonald, Wm., Chicago and Milwaukee Elec. R. R. Co., Highwood, Ill
R 30.
McNulta, Herbert, Anaconda Copper Mining Co., Anaconda, Mont.
P 39, 44. R 21. U 15, 32. W 23, 25. X 33, 34. Y 33, 34, 42, 44.
Meston, T. M., Second Vice-Pres. The Emerson Elec. Mfg. Co., St. Louis, Mo.
V 42. Y 26, 27.
Milne, James, British Columbia Elec. Ry. Co., Ltd., Vancouver, B. C.
D 2, 5, 6, 16. S 11.
Moore, J. L., Public Service Corp. of N. J., Camden, N. J.
P 9, 10, 13, 19, 21. R 1, 3. S 2, 3, 4, 13, 15.
Morrison, Douglas P., Engr. Public Service Corp. of N. J., Newark, N. J.
M 2, 5, 6. S 4, 5. U 10, 11, 37.
Moultrop, I. E., M. Engr. The Edison Elec. Ill'g Co. of Boston, Boston, Mass.
A 6. I 10.
Munns, C. K., Pres. and Mgr. Corning Lt., Ht. and Pr. Co., Corning, Iowa.
S 1, 3. T 19. Y 1, 42.

N

Neth, D. B., Supt. Connecticut Ry. and Ltg. Co., Waterbury, Conn.
R 1.
Newbury, F. J., John A. Roebling's Sons Co., Trenton, N. J.
Q 11.
New York Edison Co., New York City.
C. A. L. U 3, 4, 5, 6. V 47. W 1, 2, 3, 5. Y 12, 15, 17.
C. D. W. H 2. I 3. T 1, 2, 3, 4, 5, 6, 7, 18, 19, 20. Y 8.
C. K. N. H 3. I 1, 2, 13. K 4, 5. P 31. R 19, 25. T 10, 11, 12, 13, 17.
E. A. M. R 20. S 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 25, 26, 27, 33, 37, 38, 42, 45. T 13, 14. U 20, 28. V 14, 15, 17, 18, 34, 35, 36, 38, 39, 44, 45, 51. W 7, 8, 20, 26. Y 38. Z 17.
W. R. B. U 7, 8, 12, 14, 16, 23, 32. Y 9, 10, 11, 29, 30, 43.
Nordstrum, L. D., Fort Wayne, Ind.
A 7. K 1. L 1. Q 11. S 1, 4.

O

Osgood, Farley, Gen. Mgr. The New Milford Pr. Co., New Milford, Conn.
B 3, 8. P 9, 19.
Ott, D. L., The Wilmington City Elec. Co., Wilmington, Del.
P 50. R 21, 23, 29. T 16.
Oviatt, W. T., Connecticut Ry. and Ltg. Co., Bridgeport, Conn.
D 1. K 5. M 2. P 10. Q 5. R 15, 17. U 9, 11, 13.

P

Partridge, Warren, Supt. United Elec. Co. of N. J., Orange, N. J.
A 7. D 9. M 4. P 2, 13. R 15. S 12, 31. U 7, 8. Y 10. Unc. 1.
Peters, A., The Durango Lt. and Pr. Co., Durango, Colo.
A 8. D 24. G 7. K 1, 3, 5, 21, 22, 23, 24, 27. L 2, 3, 4, 5, 6, 8, 11, 12, 13. M 1, 2, 3, 4, 9, 14. O 2, 10. P 25, 27, 32, 33, 34, 41. Q 11. R 15, 16, 17, 20, 21. S 37, 39. U 1, 20, 21, 24, 28, 30, 31. W 23, 24, 25, 26. X 12, 17, 23. Y 34, 42, 44. Z 12, 18, 19. Unc. 1.
Philadelphia Elec. Co., The, Philadelphia, Pa.
C 5, 9. D 3, 7, 23. E 6, 8. F 9. G 5. I 11, 12. K 6, 13, 15. L 2. O 5, 6. Q 5. T 14, 21. U 1, 5, 7, 8, 9, 10, 11, 12, 14, 16, 31, 34, 36. V 11, 12, 15, 17, 25, 26, 49. Y 28.
Phillips, E. F., Peninsular Elec. Lt. Co., Detroit, Mich.
S 11, 46.
Porter, Louis I., Chicago Edison Co., Chicago, Ill.
L 1, 4.

R

Radley, G. R., Milwaukee, Wis.
Q 10. R 11. U 7, 8, 9.
Rae, Frank B., Jr., Secy. The C. W. Lee Co., Newark, N. J.
V 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 32, 34, 47.
Richardson, Geo. W., Consulting Engr., Chicago, Ill.
C 1, 3. D 14, 18, 20. O 4, 8.
Richardson, R. E., Gen. Mgr. Kansas City Elec. Lt. Co., Kansas City, Mo.
J 3.
Roberts, E. R., Nernst Lamp Co., Pittsburgh, Pa.
S 45, 46, 47.
Rollins, R. W., Gen. Mgr. Hartford Elec. Lt. Co., Hartford, Conn.
T 21.
Ryan, W. D'A., Ill'g Engr. General Elec. Co., West Lynn, Mass.
S 27, 40. 41.
Ryder, H. E., Fall River Elec. Lt. Co., Fall River, Mass.
M 5. P 26, 44. S 15. T 2, 12. V 15, 48. W 23. Y 12, 24.

S

Sampson, F. D., Supt. Catawba Pr. Co., Charlotte, N. C.
A 8. C 9. D 24. H 7, 8. K 4, 21, 22. M 1, 4, 6, 8. N 1. O 5, 6, 7, 10. P 1, 3, 4, 9, 10, 12, 13, 15, 17, 19, 22, 26, 27, 30, 31, 32, 33, 34, 36, 37, 38, 39, 43, 44. R 3, 17, 28, 29. S 2, 5, 8, 10, 22, 23, 27, 31, 37, 43. T 11, 12, 13, 14. U 6, 14, 23, 24, 26, 29. V 19, 20, 21, 23, 25. W 24, 25. Y 39, 41. Z 16, 18.
Schak, B. A., Big Fork Elec., Pr. and Lt. Co., Kalispell, Mont.
B 8. K 3, 5. P 19. R 5.

Schermerhorn, E. E., Chicago Edison Co., Chicago, Ill.
P 3, 4, 5.
Schwabe, Walter P., Public Service Corp. of N. J., Rutherford, N. J.
P 33, 38, 44. U 26, 32. Y 42, 44.
Serrel, F. J. P., Chicago Edison Co., Chicago, Ill.
P 24.
Shaw, Benjamin F., Co., Wilmington, Del.
G 1, 2, 4, 6, 8, 13, 14.
Shurtz, James R., Auditor Public Service Corp. of N. J., Camden, N. J.
W 1, 2, 3, 10, 11, 12, 18, 19. X 2, 3, 9, 10, 11, 12, 15, 16, 17, 18, 20, 21, 22. Y 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 17, 20, 21, 24, 26, 27, 28, 30. Z 15.
Smith Ernest F., Chicago Edison Co., Chicago, Ill.
A 7. F 3. K 1, 3, 4, 5, 7. M 1, 2, 5. P 8, 16, 21, 24. Q 4, 5.
Smith, F. Ellwood, W. Somerville, Mass.
S 15, 17, 28. U 2, 5, 7, 12, 13, 16. V 12, 13, 15, 19, 20. W 3, 17, 20, 22. X 12, 17. Y 4, 26, 27. Z 2, 15.
Smith, I. W., Bishop Gutta-Percha Co., New York City.
Q 11.
Smith, P. H. W., Standard Underground Cable Co., Pittsburgh, Pa.
Q 11.
Smith, S. H., Marion Lt. and Htg. Co., Marion, Ind.
X 10, 11.
Spiller, F. R., Public Service Corp. of N. J., Metuchen, N. J.
B 5, 6, 7, 12. D 26. E 12. H 7, 8. I 8. K 5, 10, 12, 13, 17, 19, 20. M 9. P 19.
Sprague, H. A., Secy. Shiawassee Lt. and Pr. Co., Corunna, Mich.
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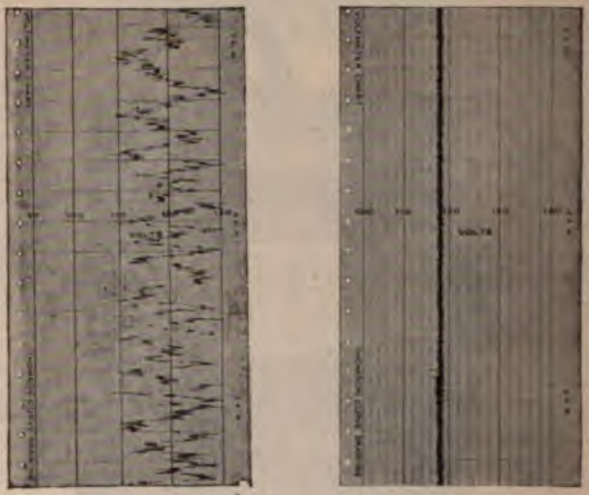

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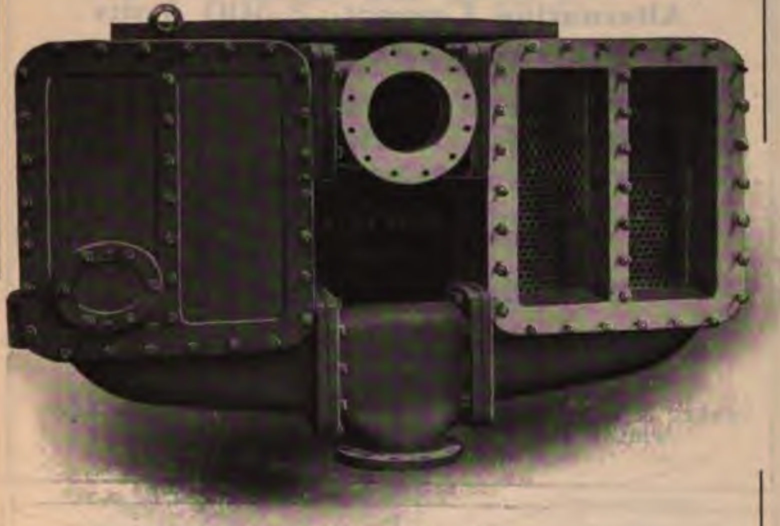

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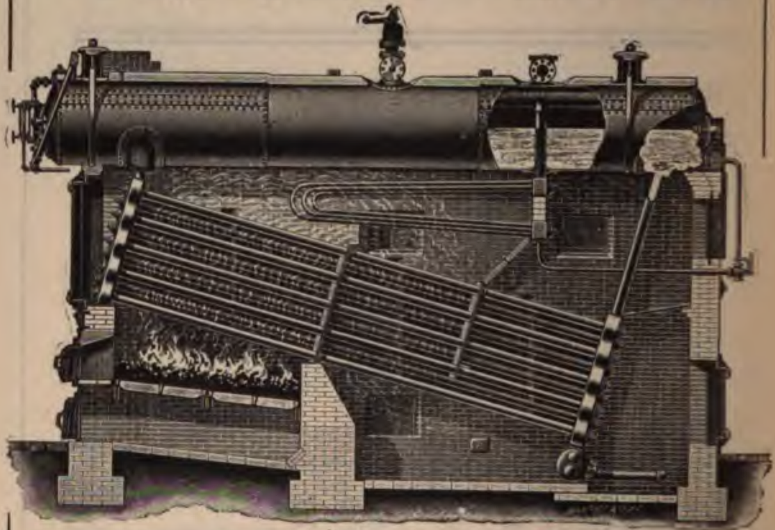

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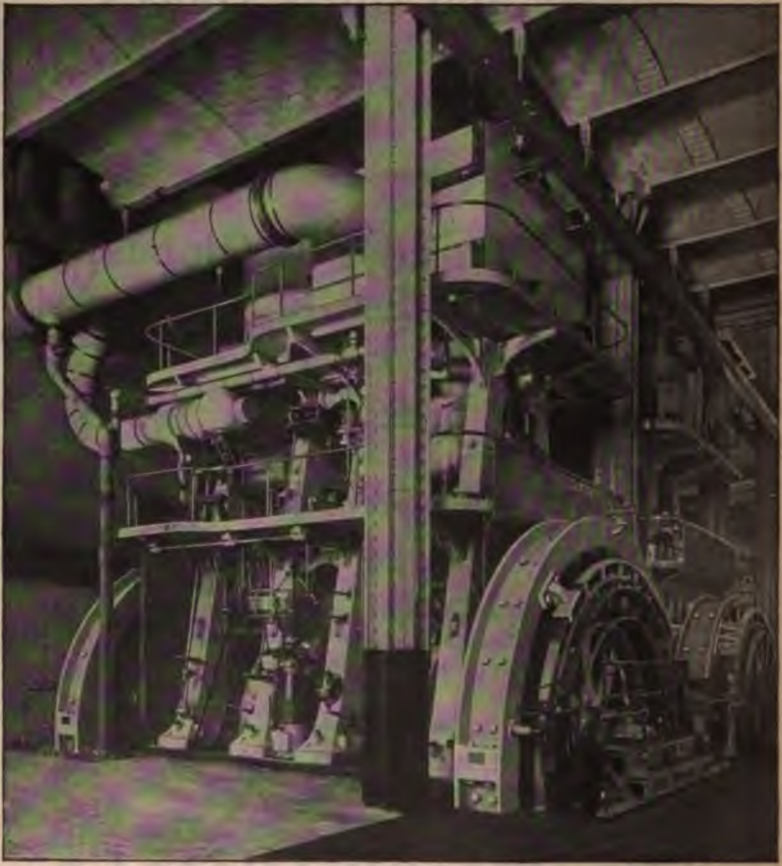

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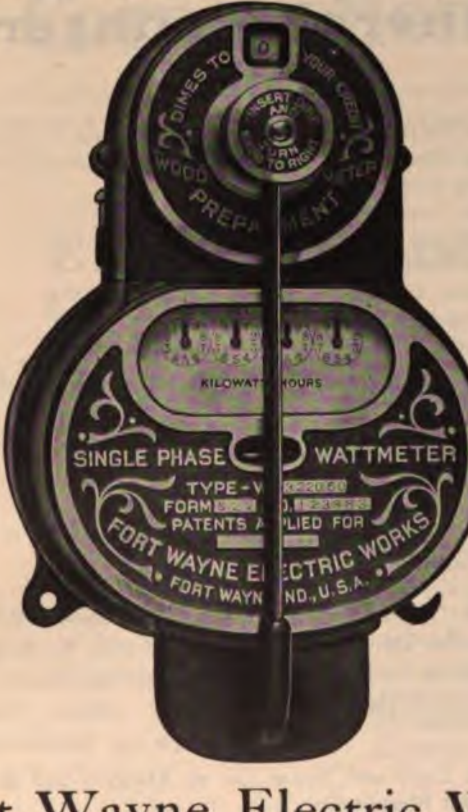

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